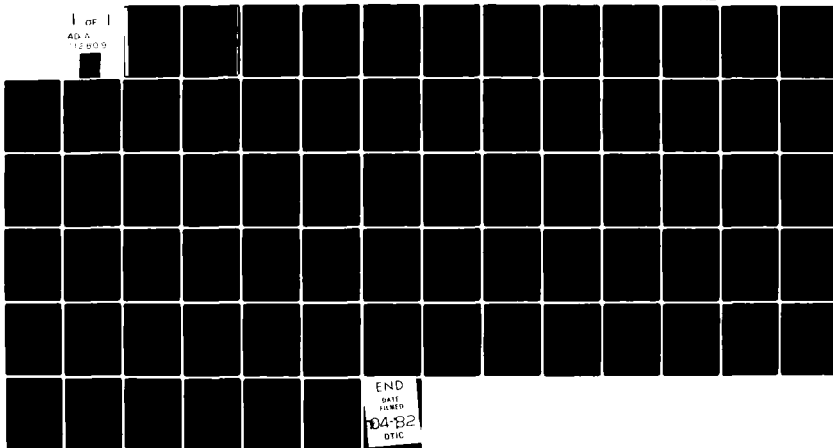


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**SUITABILITY OF SHALE FUELS
FOR ARMY GENERATOR SETS**

**INTERIM REPORT
AFLRL No. 142**

By

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San Antonio, Texas**

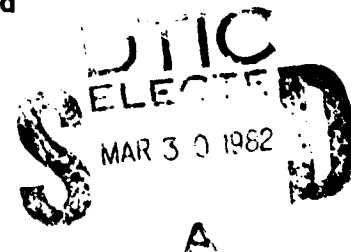
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)		
Gasoline, diesel, and gas turbine generator sets were examined to determine which shale fuel properties might adversely affect their performance. Information from engine manufacturers, fuel system manufacturers, U. S. Army Troop Support and Aviation Readiness Command (USATSARCOM) personnel and existing literature was consulted to identify existing/potential problems. Known shale fuel properties were presented and compared to military specifications.		

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Generator sets were separated into major grouping by the fuel systems they employ. A listing of generator sets was included in order to facilitate generator set selection for testing.

In general, the performance of shale fuels seemed to be comparable to that of petroleum fuels. Long-term problems such as elastomer degradation, poor life, and difficult cold weather starting may manifest themselves if refiners are unable to meet military specifications. Based on the fuels produced to date, refiners should be able to meet specifications and provide shale fuels suitable for generator set operation. Several fuel properties not covered in military specifications (such as lubricity and hydrocarbon composition) were seen as potential problem areas. A recommended test procedure has been provided to test the areas of concern presented in this report.

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FOREWORD

The work reported herein was conducted at the U.S. Army Fuels and Lubricants Research Laboratory (USAFLRL) located at Southwest Research Institute, San Antonio, Texas, under Contract Nos. DAAK70-80-C-0001 and DAAK70-82-C-0001, during the period of March 1980 through September 1981. The contracting office's representative was Mr. F.W. Schaekel, Fuels and Lubricants Division, Energy and Water Resources Laboratory (DRDME-GL). The project technical monitor was Mr. W.A. Summerson, U.S. Army Mobility Equipment Research and Development Command (DRDME-EM).

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I. INTRODUCTION

The U.S. Army uses a wide variety of generator sets powered by either gasoline, diesel, or gas turbine engines. Engines for these generator sets are manufactured by 21 different manufacturers. These engines are designed to operate satisfactorily on military specification fuels. The Department of Defense (DOD) is expanding its capabilities to utilize multisource mobility fuels. The objective of this report is to investigate the feasibility of operating Army generator sets on shale-derived fuels and to recommend appropriate test procedures for operational verification.

Material for this report has been gathered from a variety of sources. A list of generator sets has been provided for reference in Appendices A through D. Many laboratory analyses of shale fuels were gathered in order to determine the fuel properties which might affect generator set operation. The results of several performance tests were included in order to provide data on combustion characteristics, deposit-forming tendencies, and fluid-handling qualities. These tests were not necessarily in generator set engines but are presented as indicators of overall fuel performance. Engine and fuel system manufacturers were contacted in order to obtain industrial data and opinions on shale fuels. Lastly, material compatibility has been examined in order to determine its impact on generator set operation.

Shale crudes generally contain significant amounts of nitrogen compounds that, if left untreated, would decrease the thermal and storage stability of the finished fuels.^{(1)*} In order to combat this, the refiners have been heavily hydrotreating the finished fuels. Unfortunately, hydrotreating also reduces the lubricity of the fuel.⁽²⁾ For this reason, the question of fuel lubricity has been addressed as it applies to Army generator sets.

*Underscored numbers in parentheses refer to the list of references given at the end of this report.

II. GENERATOR SETS

Appendices A through D present the generator sets used by the DOD.(3) Gasoline engine driven (GED) generator sets (0.5, 1.5, 3, 5, and 10 kW) are designed to operate satisfactorily on MIL-G-3056D(4) and VV-G-1690B(5) specification fuels (automotive gasolines). Diesel engine-driven (DED) generator sets are designed to operate primarily on VV-F-800C(6) specification fuels (DF-A, DF-1, and DF-2) and MIL-F-16884G specification fuels (DFM).(7) Gas turbine engine driven (GTED) generator sets will consume a variety of distillate fuels, including MIL-T-5624L(8)(JP-4 and JP-5), and VV-F-800C fuels.

GED generator sets are powered by Military standard engines. They are designed for ease of maintenance and repair, maximum parts interchangeability, and a performance life of 1500 hours. They have been manufactured by Continental Motors, Wisconsin Motors, Chrysler Outboard Corp., or Hercules Engine, Inc. Power units (PU) are trailer-mounted generator sets. Units with multiple generator sets are designed to provide continuous power with one generator set operating at all times.

III. FUEL/ENGINE COMPATIBILITY

The compatibility of a given fuel and engine is determined by the fuel properties and the mechanical design of the engine. Engines on generator sets are quite diverse and employ a number of different mechanical designs. Each design is sensitive to a different set of fuel properties (e.g., a diesel has a cetane number requirement, while a gas turbine does not). In order to determine which fuel properties are critical, engines have been separated into three classes: gasoline, diesel, and gas turbines. Within each classification, there will be variations in mechanical design (e.g., some diesel injection systems will be more critical of fuel lubricity than others). Based on such variations, gasoline, diesel, and gas turbine engines used on Army generator sets have been subdivided into the groupings of Table 1. Subdivisions indicate fuel systems that, because of similarity of design,

TABLE 1. GENERATOR SET ENGINE GROUPINGS

I. Gasoline Engines

A. Engines with carburetors

1. Military standard engines
 - a. 1A08-1, 2, 3 - 0.4, 0.5 kW
 - b. 2A016-2, 3 - 1.5 kW
 - c. 2A042-1, 2, 3, - 5 kW
 - d. 4A032-1, 2 - 3, 4.2 kW
 - e. 4A084-2, 3 - 10 kW
2. Other engines
 - a. Teledyne Continental FS162 - 10 kW
 - b. Teledyne Continental YS69 - 5 kW
 - c. Wisconsin MVH4D - 7.5, 10 kW
 - d. Wisconsin MTHDE - 5 kW
 - e. Wisconsin MAENLD - 3 kW
 - f. Wisconsin MBKND - 2 kW
 - g. Hercules 1XB3ER - 10 kW
 - h. Clinton 416-1300 - 2 kW
 - i. Briggs & Stratton 60432 - 0.3, 0.4 kW
 - j. Homelite A54770 - 0.125, 0.5 kW
 - k. Homelite XL-12 - 0.15 kW

II. Diesel Engines

A. Detroit Diesel unit injector system

1. Detroit Diesel, Series 71, 2 Cycle
 - a. 4045C (4-71) - 45 kW
 - b. 6045C (4-71) - 100 kW
 - c. 3045C (3-71) - 45 kW
2. Detroit Diesel, Series 53, 2 Cycle
 - a. 5043 (4-53) - 45 kW
 - b. 5033-7101 (3-53) - 15, 30 kW

B. Cummins pressure-time (PT) fuel system

1. Cummins, J Series, supercharged engines
 - a. JS-G/S/S52300 - 45 kW
 - b. JIS-600 - 45 kW
 - c. JS-6-1G - 45, 60 kW
2. Cummins, N Series, 4-valve head, 123.3-in.³ (2.02-L)/cylinder
 - a. NHRS-600 - 150-165 kW
 - b. NVH-12-G - 150 kW
 - c. NH-220-BIG - 100 kW
 - d. NH-220-G - 60 kW

TABLE 1. GENERATOR SET ENGINE GROUPINGS (continued)

3. Cummins, C Series, 464-in.³ (7.6-L) displacement, 180 horsepower (134 kW) 6 cylinder in line
 - a. C 180 - 60 kW
 - b. C 180B1 - 60 kW
 - c. C18031 - 60 kW
4. Cummins, 1710 in.³ (28 L), V-configuration, turbocharged after cooled
 - a. VTA-1710G - 500 kW
5. Cummins, K Series, individual cylinder heads, turbocharged after cooled, 2300 in.³ (37.68 L)
 - a. KTA 2300-G - 750 kW
- C. Caterpillar scroll type fuel system
 1. Caterpillar, 4.75-in. (12-cm) bore, 6 in. (15.2 cm) stroke, 638-in.³ (10.45-L) displacement
 - a. D 334T - 200 kW
 - b. D 333C - 100 kW
 2. Caterpillar, 12 cylinder vee, 6.25-in. bore, 8-in. stroke 2945-in.³ (48.26-L) displacement
 - a. D 398 - 1500, 2000 kW
- D. Caterpillar sleeve-metering fuel system
 1. Caterpillar, 6 cylinder in line, 638-in.³ (10.45-L) displacement
 - a. D3306T - 100 kW
- E. Robert Bosch, multi-plunger, oil lubricated camshaft, model PE6P
 1. Allis Chalmers 5½-in. (13.3 cm) bore, 6½-in. (16.5-cm), 6 cylinder
 - a. Allis Chalmers 25000 - 200 kW
- F. American Bosch, integral fuel transfer pump, APR injection pump
 1. In line, 1905-in.³ (31.2-L) displacement, 7-in. (17.8-cm) bore x 8½-in. (21-cm) stroke
 - a. Waukesha F19050 SV-E812 - 200 kW
 - b. Waukesha 6NKDBS4N - 150 kW
 2. Overhead valve, 4 cycle, vertical inline, 3.5-in. (8.9-cm) bore, 3.625-in. (9.2-cm) stroke
 - a. Onan DJE-99E/8485 - 5 kW
 - b. Onan DJF-99F/9487 - 10 kW
- G. Stanadyne D Series distribution pumps, fuel-lubricated
 1. Teledyne Continental, 4-5/16 in. (11-cm) bore, 4-7/8 in. (12.4-cm) stroke, 427-in.³ (7.0-L) displacement
 - a. TD 427 - 45 kW

TABLE 1. GENERATOR SET ENGINE GROUPINGS (continued)

2. Teledyne Continental, 5-9/16 in. (14.1-cm) bore, 5 1/2-in. (14-cm) stroke, 802-in.³ (13.14-L) displacement
 - a. SD 802 - 45, 60, 100 kW
3. Teledyne Continental, 4-3/4 in. (12-cm) bore, 5-3/8 in. (13.7-cm) stroke, 572-in.³ (9.37-L) displacement
 - a. RD 572 - 60 kW
4. Teledyne Continental, 4-5/8 in (11.7-cm) bore, 6-in. (15.2-cm) stroke, 403-in.³ (6.6-L) displacement, in line 4
 - a. JD 403 - 30 kW
5. Hercules, 3.75-in. (9.5-cm) bore, 4.5-in. (11.4-cm) stroke, 4 cycle
 - a. D 198 (4 cylinder) - 15, 30, 60 kW
 - b. DD 198 (4 cylinder) - 15 kW
 - c. D 298 (6 cylinder) - 30 kW
 - d. Winpower, DD198 (modified Hercules Engine) - 15 kW
6. Allis Chalmers, 4.5-in (11.4-cm) bore, 5-in. (12.7-cm) stroke, 6 cylinders
 - a. 3500 - 60 kW
7. Allis Chalmers, 6 cylinder, 4.44-in (11.3-cm) bore, 5.56-in. (14.1-cm) stroke
 - a. 11000 - 100 kW

III. Gas Turbine Engines

A. AiResearch (Garrett)

1. AiResearch fuel system including pump, governor, differential pressure bypass valves and metering valves
 - a. GTP70-50 - 30, 50 kW
 - b. GTCP85-127 - kW rating not found
 - c. GTP70-18-1 - 30 kW
 - d. GTP30-40 - kW rating not found

B. Solar Turbines

1. Solar, positive displacement fuel pump, flyball governor, pressure atomizer, air atomizers
 - a. T-1020 - 750 kW
 - b. TITAN - 60 kW
 - c. Gemini - 10 kW

would be expected to react similarly to shale fuels. Within each subdivision are the engine manufacturers, engine models, and kilowatt rating of generator sets using the particular fuel system.

A. Gasoline Engines

Fuel properties of concern are octane number, aromatic content, volatility (Reid vapor pressure), sulfur content, contaminants, and oxidation stability.

Unfortunately, very limited quantities of shale-derived gasoline have been produced to date. Because of this, there is a limited amount of data on fuel properties and engine performance. Approximately 645 barrels of shale-derived NATO gasoline (specification F46) were shipped from the Gary Western Refinery in 1975.⁽⁹⁾ This fuel was refined from shale oil crude processed by the Paraho process. Paraho fuels from this first batch have commonly been referred to and are here referred to as Paraho-I fuels. Laboratory inspections of the Paraho-I gasolines are shown in Table 2 and compared with MIL-G-3056D and VV-G-1690B specifications. The Paraho-I gasolines did not meet MIL-G-3056D specifications in terms of Reid vapor pressure (4/18/75 run only), oxidation stability, research octane number, and motor octane number. The shale gasoline did not meet VV-G-1690B antiknock index (R+M/2) specifications for most geographic areas. It should be noted that several tests required by MIL-G-3056D and VV-G-1690B were not performed on the shale gasoline. Octane numbers may prove to be a problem and should be investigated. Low octane numbers generally cause knock which in turn causes poor performance and severely reduced engine life. The slightly high Reid vapor pressure exhibited by the shale gasoline could lead to vapor lock and poor performance when the unit was operated in a hot environment. Corrosive sulfur content of the fuel, as indicated by the copper strip corrosion test, appears to be acceptable. The low thermal stability exhibited by the fuel would cause rapid fuel degradation leading to filter plugging and engine operating difficulties, particularly in a hot environment. Gary⁽¹⁰⁾ states that additional hydrogenation under more severe conditions should eliminate the oxidation stability problem.

TABLE 2. PROPERTIES OF PARAHO-I GASOLINE

ASTM Test Method	ParaHo-I Gasoline 4/2/75	ParaHo-I Gasoline 4/18/75	MIL-G-3056C Requirements Type I	VV-G-1690B Requirements Class C Regular
Reid Vapor Pressure, kPa (lb)	60.2 (8.8)	67.8 (9.9)	47.9-61.6 (7-9)	79.3 (11.6) max
Copper Strip Corrosion, (3 hr/50°C)	1a	1a	1 max	1 max
Total Sulfur, Wt%	0.003	0.003	0.1 max	0.15 max
Oxidation Stability, min.	360+	360+	480 min	240 min
Existent Gum, mg/100 ml	2.8	2.2	NR	5 max
Motor Octane Number	81.6	81.8	83 min	NR
Research Octane Number	90.6	90.7	91 min	NR
Distillation				
10% Evap., °C (°F)	54.4 (130)	54.4 (130)	50-70 (122-158)	60 (140) max
50% Evap., °C (°F)	101.6 (215)	94.4 (202)	88.8-109.4 (192-229)	116(241) max
90% Evap., °C (°F)	163.3 (326)	153.3 (308)	132-180 (270-356)	185 (365) max
Residue, Vol%	1.0	1.0	2.0 max	NR
Aromatics, Vol%	46.7	NA	NR	55 max
D 323 or D 2551				
D 130				
D 1266 or D 2622				
D 525				
D 381				
D 2700				
D 2699				
D 86				
D 1319				

NR = Not required
NA = Not available

The fuel system on gasoline-powered generator sets generally consists of a tank, filter, fuel pump, carburetor, and associated fuel lines. This type of system is inherently insensitive to fuel lubricity because the pump is low pressure and does not rely heavily on the fuel for lubrication. Six manufacturers of gasoline engines for Army generator sets were queried about fuel lubricity. Responses were received from Teledyne Continental Motors, Teledyne Wisconsin Motor, and Briggs and Stratton Corporation. Both Teledyne Continental and Teledyne Wisconsin did not anticipate any problems with fuel lubricity, (11,12) while Briggs and Stratton did not comment on fuel lubricity. (13) A literature search failed to turn up any work performed on the lubricity of shale gasolines. This may be due to the small quantities of shale gasolines produced to date.

A search for engine tests using shale-derived gasoline revealed three tests. These were performed using Paraho-I gasoline in the military L-141 four-cylinder engine by the Army Fuels and Lubricants Research Laboratory (AFLRL) in 1975. The first two tests were run for 225 and 50 hours, respectively. Fuel instability (high gum) caused intake valve deposition and excessive exhaust valve erosion/corrosion on both tests. (14) Another sample of Paraho-I gasoline was received from MERDC and run through a 225-hour test cycle in the L-141 engine. This sample had been reprocessed using severe hydrotreating in order to improve fuel stability. On this run, no problems were noted, and the engine valves showed no signs of abnormal wear. (15) No emissions data have been found from shale gasoline runs.

Elastomer components on gasoline-driven Army generator sets that may be affected by shale fuels are fuel hoses, pump diaphragms, float needle tips and carburetor gaskets. In particular, increasing concentrations of aromatics, sulfur or naphthenes could cause swelling or mechanical failure of elastomeric components. Because of the unavailability of shale gasolines, no data have been gathered on elastomers used in gasoline-powered generator sets. Figure 1 shows the effects of aromatic content on the volume swell of four different elastomers. (16) The Buna-N illustrated is a high acrylonitrile type which has greater fuel resistance than low acrylonitrile types. Even so, it experiences large volume swell at aromatic concentrations above 30 percent. Typical commercial gasolines have aromatic contents of 20-35

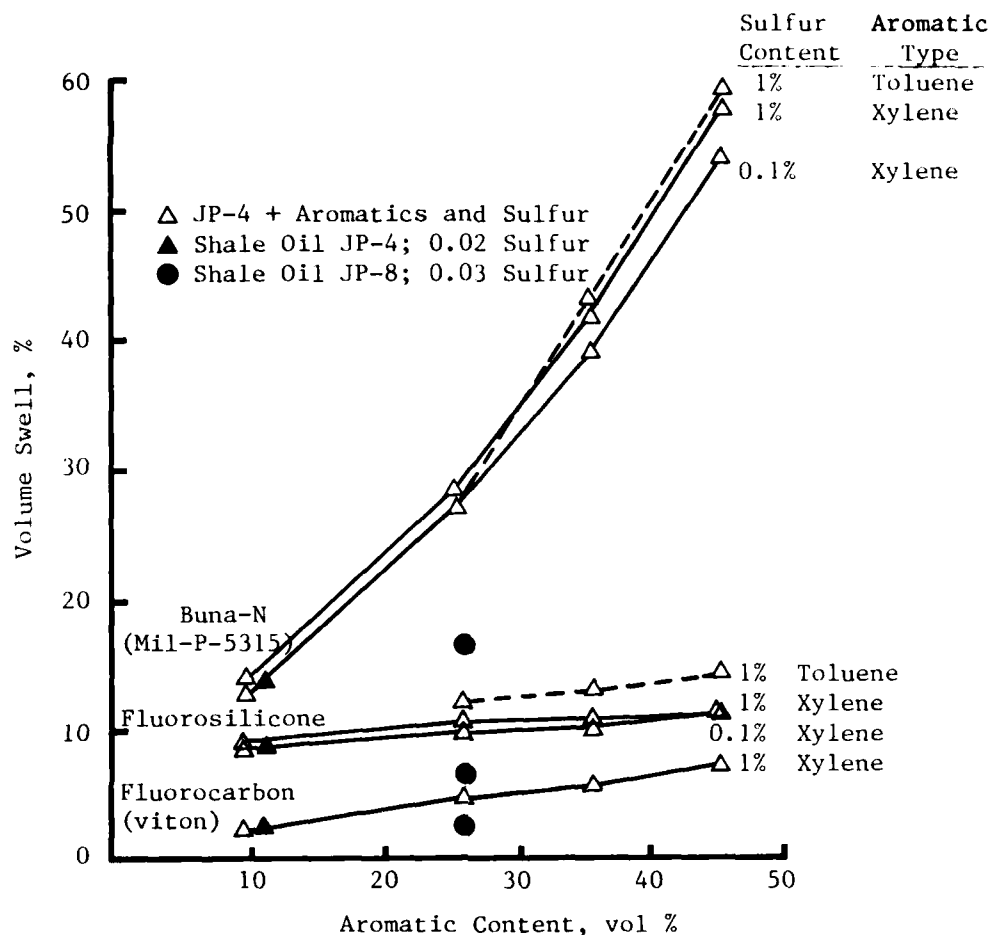


FIGURE 1. EFFECTS OF AROMATIC TYPE AND SULFUR ON VOLUME SWELL OF ELASTOMERS

percent by volume. Military specification VV-G-1690B sets an upper limit of 55 percent on aromatic content. The one shale-derived gasoline available for testing contained 46.7 percent aromatics. This may be due to catalytic reforming during the refining process in order to raise the octane number. Gasoline-powered generator sets utilizing Buna-N components in noncaptive service may experience problems with shale fuels due to the relatively high aromatic content. Certain types of sulfur may severely degrade elastomers and must be kept within specifications.

B. Diesel Engines

Diesel fuels have been refined from oil shales by several different processes. Table 3 lists properties of some shale-derived diesel fuels and compares them to VV-F-800C and MIL-F-16884G specifications. Properties of concern are cetane number, cloud point, volatility, viscosity, sulfur content, contaminants, carbon residue and stability. Additional properties of concern not covered by military specifications are lubricity and hydrocarbon composition. Perhaps the oldest of these fuels is the Paraho-I DFM.(9) It does not meet VV-F-800C specification in terms of density, pour point, carbon residue, or total acid number (TAN). It does not meet MIL-F-16884G specifications in terms of pour point, carbon residue, TAN, kinematic viscosity, color, and neutrality. The high pour point could lead to filter pluggage and/or poor performance in cold weather. The high carbon residue is thought to contribute to deposit formation and reduced engine life. The increased kinematic viscosity would be beneficial in providing increased lubricity but may decrease engine thermal efficiency by decreasing fuel atomization. The high TAN and negative neutrality indicate that the fuel is acidic and may corrode the fuel system. The color rating of 8+ implies the presence of contaminants that may increase filter plugging. The Paraho-I fuels were one of the first batch of shale fuels produced, and subsequent fuels have exhibited inspection properties closer to specifications.

The Paraho-II shale DFM, AL-8437-F, met all VV-F-800C and MIL-F-16884G specifications. This may be because the Paraho-II fuels received more severe hydrogenation and chemical treatment than did the Paraho-I fuels.

Data on the Chevron Research Co. Paraho DF-2 were rather limited, but the properties reported met the requirements of VV-F-800C and MIL-F-16884G.(18) Similarly, the data on the Occidental HCL-extracted fuel were limited, but the reported data met specification requirements.(19) Complete analyses of these fuels would be necessary to pass the specification tests.

Volatility requirements were met by all the shale fuels as evidenced in the D 86 distillations. Sulfur content was acceptable in all fuels reported.

TABLE 3. PROPERTIES OF SHALE-DERIVED DIESEL FUELS

PROPERTIES	METHOD	DF-2 OCONUS VV-F-800C REQUIREMENTS	SHALE DF-2		SHALE DF-2		SHALE DFM		DFM MIL-F-16884G REQUIREMENTS
			OCCIDENTAL HCL EXTRACTION	CHEVRON PARAHO	AL-8437-F PARAHO-II	PARAHO-I			
Density, kg/l @ 15°C	D 1298	0.815-0.860	0.834	0.8353	0.8353	0.8353	0.8612	RECORD	
Flash point, °C	D 93	56 min.	99	NA	NA	60	76	60 min	
Cloud point, °C	D 2500	(1)	NA	NA	NA	14	NA	-1.1 max	
Pour point, °C	D 97	-18 max. (2)	NA	-18	-18	-18	10	-6.7 max	
K. vis @ 20°C, cSt	D 445	(1.8-9.5)	NA	NA	NA	NA	NA	NR	
Distillation, °C	D 86	Report	279	268	264	264	311	NR	
50%		357 max	310	337	295	295	346	357.2 max	
90%		370 max	343	358	312	312	363	NR	
End point		3 max	NA	NA	1	1	3	3 max	
Residue, vol%									
Carbon residue, vol%									
bottoms, mass %	D 524	0.2 max	NA	NA	0.04	0.04	0.6	0.2 max	
Sulfur, mass %	D 1552								
	129,2622	0.7 max	0.0011	0.002	0.004	0.004	0.44	1.0 max	
Copper strip corrosion									
3 hr. @ 50°C	D 130	1 max	NA	NA	NA	NA	NA	NR	
Ash, mass %	D 482	0.02 max	NA	NA	0.0	0.0	0.0	0.005 max	
Accelerated stability									
total insolubles, mg/100 ml	D 2274	1.5 max	NA	NA	0.2	0.2	NA	2.5 max	
Neutralization number									
TAN	D 974	0.1 max	NA	NA	0.001	0.001	0.7	0.3 max	
Particulate contamination,									
mg/liter	D 2276	10 max	NA	NA	0.5	0.5	NA	NR	
Cetane number	D 613	45 min	NA	NA	49	49	56.7	45 min	
K. vis @ 37.8°C, cSt	D 2500	NR	NA	2.7	2.71	2.71	5.54	1.8-4.5	
Copper strip corrosion @ 100°C	D 130	NR	NA	NA	1A	1A	1A	No. 1 max	
Color	D 1500	NR	NA	NA	0.5	0.5	8+	3 max	
Demulsification, min.	D 1401	NR	NA	NA	5	5	NA	10 max	
Neutrality	FTM 791-								
	5101	NR	NA	NA	Neutral	Neutral	Negative	Neutral	
Aniline point, °C	D 611	NR	NA	NA	67	67	49	Record	
Appearance	NS	NR	NA	NA	White,	White,	NA	Clear,	
					Clear	Clear		Bright	

(1) = varies according to location

(2) = for Europe and Korea

NR = not required

NA = not available

NS = not specified

Data on particulate contamination were not available for three of the four fuels. There is some doubt that the Paraho-I fuel could have passed the particulate contamination test. Data on accelerated stability were also missing for three of the four fuels. Again, there is some doubt that the Paraho-I fuel could have passed the requirements. Shale fuels undergoing hydrotreating of adequate severity to an acceptable nitrogen level would probably pass stability requirements.

Fuels systems on diesel-powered generator sets generally consist of a tank, primary filter, secondary filter, fuel transfer pump, fuel injection pump, governor, injectors, and associated fuel lines. Items that rely on fuel for lubrication are the fuel transfer pump, fuel injection pump, injectors, and, in some cases, the governor. Eleven manufacturers of diesel engines used on Army generator sets were queried about fuel lubricity. Responses were received from Detroit Diesel Allison, White Engines Inc., Cummins Engine Co. Inc., Teledyne Continental Motors, Stewart & Stevenson Services Inc., Allis-Chalmers, Caterpillar Tractor Co., and Waukesha Engine Division.

Based on inspection properties and performance investigations, Detroit Diesel did not foresee lubrication problems with shale fuels. They cautioned that they had not thoroughly investigated the prolonged contact of oil shale fuels with copper, injector components, and fuel pumps.(20) White Engines expressed the opinion that the viscosity of the fuel determined its lubricity. Since shale fuels have viscosities similar to DF-2, White did not expect any trouble.(21) Cummins Engine Co. forwarded their bulletin No. 3379001-03, "Fuel for Cummins Engines," and stated that fuels meeting the required specifications would operate satisfactorily in their engines.(22) All listed properties in Table 3 fall within the Cummins specifications. Teledyne Continental Motors stated that it may be necessary to add lubricating oil to a diesel-type fuel in order to prevent damage to the injection pump plungers and plunger bores.(11) Stewart & Stevenson Services Inc. expected injectors and fuel pumps to experience unusually fast wear rates with shale fuels (this assumes low-lubricity fuels). Noticeable effects would be injector sticking, misfiring, and rough engine performance.(23) Allis-Chalmers stated that they had done no testing with shale fuels, but

would expect only fuel pumps and injector nozzles to be affected by reduced lubricity.(24) In addition, Allis-Chalmers included a fuel specification that all shale fuels in Table 3 passed. The Caterpillar Tractor Co. did not have any endurance data on shale fuels but did provide good performance and emission information.(25) Lastly, Waukesha Engine Division stated that they had no experience in the lubricity of shale fuels, but they would expect the fuel transfer pump, injection pump, and fuel injectors to be affected.(26)

Two manufacturers of fuel injection equipment used on Army generator sets were queried in writing as to possible problems using shale fuels. One response received from Bendix Engine Products Division stated that they have work planned on shale fuel testing but presently had no meaningful information.(27) Telephone conversations with Stanadyne, Inc., brought out the fact that Stanadyne has received samples of Paraho-II DFM and is planning to test it in their fuel systems. Presently, however, they have no information on the durability of their systems in shale service.

Although laboratory tests for fuel lubricity are numerous, the ball-on-cylinder machine (BOCM) is the most accepted test for fuel lubricity studies.(2) Results of BOCM tests performed by the AFLRL are presented in Table 4.(28) The Paraho DFM exhibits a larger wear scar diameter (WSD) than the Cat 1-H reference fuel. Similarly, the clay-treated Paraho DFM exhibits a larger WSD than the clay-treated Cat 1-H (clay-treated fuels simulate worst-case lubricity for a given fuel by removing polar compounds). This is an indication of poor fuel lubricity of shale fuels which may lead to increased wear of fuel system components.

Two American Bosch LDT-465-1C fuel metering and distributing units were tested by the AFLRL in July 1981. One pump utilized untreated shale DFM while the other ran on clay-treated (low-lubricity) shale DFM. Both units were run at 1200 rpm for 500 hours. The unit operated on the untreated shale fuel met or surpassed all requirements of TM9-2910-226-34 (Pump, Fuel, Metering and Distributing Assembly). The unit operated on the clay-treated DFM failed to meet minimum standards at all calibration sequences.(29) This indicates that the poor lubricity of the clay-treated fuel may cause pre-

TABLE 4. BOCM TEST RESULTS

AFLRL Fuel Code	Fuel Description	No. Runs	Average WSD*, mm	Std. Dev., mm
AL-10115-F	Petroleum Cat 1-H diesel fuel	4	0.273	0.039
AL-10359-F	Clay-treated Cat 1-H diesel fuel	4	0.353	0.035
AL-10519-F	Double clay-treated Cat 1-H diesel fuel	2	0.403	0.004
AL-10150-SP-F	Paraho DFM	2	0.425	0.014
AL-10358-SP-F	Clay-treated Paraho DFM	2	0.705	0.021
AL-8466-SP-T	Paraho JP-8	3	0.395	0.023
AL-8436-SP-T	Paraho JP-5	2	0.618	0.053
AL-9847-SP-F	Geokinetics JP-4**	1	0.315	ND
AL-10451-SP-F	Clay-treated Geokinetics JP-4***	3	0.755	0.188

* WSD (wear scar diam.) = $(a+b)/2$ where a and b are major and minor axes of the wear scar ellipse, respectively. Good lubricity:

WSD = 0.42; marginal: WSD = 0.43-0.48; poor: WSD = 0.49

** Visual water contamination

*** No visual water contamination after single clay treatment

ND Not determined

mature fuel pump failures and/or poor engine performance.

The U.S. Army Troop Support and Aviation Readiness Command (TSARCOM) was contacted by letter and asked for information on fuel-related generator set engine failures. It was hoped that item managers in TSARCOM would have comments on fuel-related problems associated with particular generator sets. TSARCOM commented that they have had no experience with shale-derived fuels, but recommended three generator sets for testing. These sets were the 60-kW MEP006, the 60-kW MEP115, and the 60-kW MEP105.(30) All three generator sets employ the Allis-Chalmers 3500 engine and a Stanadyne D series injection system.

Many performance runs have been made using shale diesel fuels. Due to the limited supply of shale fuels, however, few endurance tests have been performed. Some of the tests presented herein do not use engines found in Army generator sets. These tests are, however, representative of overall diesel shale fuel performance.

In 1975, the AFLRL ran a small Onan model DJB two-cylinder diesel engine generator set on a Paraho-I diesel fuel.⁽¹⁵⁾ Note that this generator set does not employ the engine used on current DOD generator sets. This generator set has a slightly smaller bore, displacement, and power rating than the military DJE engine, but utilizes a similar fuel injection system. Results are presented in Table 5. For this short test series, there were no major changes between the Paraho fuel and petroleum DF-2 in terms of performance or emissions.

TABLE 5. RESULTS OF ONAN DIESEL GENERATOR EMISSIONS TEST
WITH SHALE-DERIVED DIESEL FUEL

<u>Fuel</u>	<u>Load, watts @ 1800 rpm</u>	<u>NO, ppm</u>	<u>NO_x, ppm</u>	<u>HC, ppm</u>	<u>CO, %</u>	<u>CO₂, %</u>	<u>O₂, %</u>	<u>Smoke No.</u>
Paraho-I	1700	380	440	69.0	0.029	4.45	14.9	0.5
	3300	510	560	46.5	0.018	5.85	12.7	0.9
	5000	510	538	48.0	0.032	8.00	9.9	2.0
DF-2	1700	360	400	56.7	0.024	4.45	14.50	0.9
	3300	500	555	51.0	0.020	5.86	12.7	1.3
	5000	503	535	43.5	0.025	8.20	9.5	1.6

A Paraho-I DFM was run in a Cummins NTCC-350 in-line six-cylinder engine with 355-in.³ (14-L) displacement. This was done in 1975 at the Cummins Technical Center. A smoke cycle, thirteen-mode California emission cycle,

and a torque curve were run for the shale DFM and a petroleum DFM. Conclusions from the tests are as follows:

"The fuel made from oil shale was dark and viscous in appearance. It also appeared to layer in the barrel. This was indicated by the fact that fuel filters would last longer on fuel taken from the top of the barrel versus fuel taken from the bottom. The average fuel filter life was about 30 minutes at full power at rated speed. The fuel was higher on BSNO₂, BSHC and fuel consumption at torque peak, and the engine was not very stable. The fuel was lower on acceleration and lugdown smoke. The higher BSNO₂ and lower lugdown smoke was probably due to the higher cetane index. The reduction in acceleration smoke was due to the increase in response time probably due to filter plugging."(31)

The engine used in the above test used the same fuel injection system as the generator set engines listed in Section IIB of Table 1. This test was of short duration and did not address the problem of fuel system durability. While the Paraho-I fuel did not appear to be acceptable for use in Cummins engines, it should be noted that this was one of the first shale fuels refined, and subsequent batches have exhibited better performance.

Another test using Paraho-I DFM was run in the Detroit Diesel 3-71 engine by the Naval Ship Engineering Center, Philadelphia Division in 1975. A 32.5-hour cyclic performance run and two MIL-F-24455 fuel calibration runs were performed and the following problems were noted: plugged fuel filters; two stuck compression rings; a clogged injector tip; internal injector wear; varnish buildup on valves; and heavy combustion deposits on the cylinder head valve deck. It was noted that the engine probably would have failed an endurance run because of the progressive nature of stuck rings. Emissions from the shale fuel were basically the same as that from conventional diesel fuels except for higher NO_x levels which occurred with the shale fuels.(15) The engine used in this test uses the same basic fuel system as generator set engines in Section IIA of Table 1.

A Paraho-II DFM was run in a Detroit Diesel 6V-53T by the AFLRL in 1980. Full-load performance determinations were performed using the shale DFM and reference DF-2. Differences in maximum power observed were so small that similar differences would be expected in fuels meeting DF-2 specifications. Brake specific volumetric fuel consumption increased 1.2 percent using the shale DFM.(32) The fuel system on the DD6V-53T is very similar to the fuel

systems recorded in Section IIA of Table 1. Endurance or emissions data were not taken during this test.

A 210-hour wheeled-vehicle cycle endurance test was performed using Paraho-II DFM in a Detroit Diesel 3-53 engine by the AFLRL in 1980. Results of the test were indistinguishable from those obtained with conventional petroleum-derived diesel fuel with similar properties.⁽³²⁾ The fuel system used in the DD3-53 engine is again similar to the generator set fuel systems listed in Section IIA of Table 1. Results of this one endurance run are encouraging and indicate that well-refined shale fuels meeting military specifications may also meet endurance and performance criteria on Army generator sets.

A Detroit Diesel 3-53 engine using Paraho-II DFM was tested by Tujeta and Clark in 1979. The Paraho fuel was compared to DF-2 in terms of engine performance and emissions. Differences were small and could be explained by the differences in physiochemical properties of the two fuels.⁽³³⁾ Again, the fuel system used in this test is similar to that found in Section IIA of Table 1.

During 1980, SwRI's Automotive Research Division performed tests with Paraho-II DFM in a two-cylinder EMD test engine. No performance differences were noted between baseline No. 2 diesel fuel and the shale fuel. It was concluded that at least for short runs the shale DFM could apparently be handled and consumed like No. 2 diesel fuel without any problems.⁽³⁴⁾

Paraho-II DFM was tested again in a single-cylinder, turbocharged, prechambered, four-stroke cycle laboratory diesel engine by a manufacturer of Navy diesel engines for the David W. Taylor Ship Research and Development Center in 1980. Performance and emission runs comparing the shale fuel and a petroleum diesel fuel revealed no significant differences.⁽³⁵⁾

Another concern with shale fuels is their effect on elastomers and other nonmetallic components. A list of nonmetallic fuel-wetted components used in engines and fuel systems typical of Army generator sets is presented in Table 6. This list was compiled from data obtained from manufacturers of

TABLE 6. NONMETALLIC FUEL-WETTED COMPONENTS
USED IN ENGINES AND FUEL SYSTEMS TYPICAL TO ARMY GENERATOR SETS

	FUEL SYSTEM MANUFACTURER				
	DETROIT DIESEL	CUMMINS	CATERPILLAR	STANADYNE	SOLAR TURBINES
Buna-N	X	X	X	X	X
Viton	X	X	X	X	X
Sirvene	X				
Cellulose Triacetate		X			
ASTM F 104 Cork Resin			X		
Epoxy Enamel			X		
SAE J2002 BG			X		
3M Epoxy 2214			X	X	
Teflon®			X		
Glass-Filled Tenite 6G9PTMT			X		
Cellulose Fiber W/Glass			X		
Vinyl Plastisol			X		
Clay-Coated Paper			X		
Urethane				X	
Pellathane				X	

the various generator set engines. Due to the obsolescence of some of these engines, time constraints, and the proprietary policies of some manufacturers, this list is by no means all-inclusive. Fuel constituents that can be deleterious to elastomers are aromatics, sulfur, naphthenes, peroxides, and polysulfides.(16) Of these, the major concerns with shale fuels are

sulfur content and aromatic content. Sulfur content is, of course, controlled by current diesel fuel specifications. Sulfur specifications should be stringently adhered to in future shale fuels. The shale fuels listed in Table 3 easily met sulfur requirements. Aromatic content is not limited in current diesel fuel specifications. This will probably not cause a problem because the hydrogenation necessary to remove fuel-bound nitrogen decreases aromatic content. It does this, however, at the expense of increasing the naphthene contents of the fuel. Little data are available on the effects of naphthenes on elastomers. Should naphthene contents of future shale fuels increase significantly over present levels, material testing would be necessary to determine the impact on elastomers. Peroxides are products of severe hydrogenation and may present some material compatibility problems.

C. Gas Turbine Engines

Jet fuels have been refined from oil shales by several different processes. Table 7 lists properties of some shale-derived jet fuels and compares them to MIL-T-56244L grade JP-4 and JP-5 specifications. Properties of concern are lubricity, aromatic content, freezing point, volatility, viscosity, sulfur content, hydrogen content, contaminants, stability, and naphthene content. Data on the GC2-4 sample of Paraho JP-4 were rather limited, but all properties reported met JP-4 specifications.(36) The Geokinetics JP-4, AL-9847, did not meet JP-4 requirements in terms of 20 percent recovered temperature, vapor pressure, freezing point, and preheater deposit code.(37) These first three areas of concern would present minimal problems in generator set operation as generators are less discerning than jet airplanes; the high deposit code rating, however, could lead to atomizer plugging under part load conditions. The Occidental JP-4, sample GC1-4, was not tested for many of the JP-4 requirements.(36) The low vapor pressure would adversely affect generator set operation only at very low temperatures. The Occidental JP-4 (conventionally refined), again missing many of the required tests, failed to meet JP-4 requirements in terms of distillation end point, freezing point, and vapor pressure.(19) None of these discrepancies should greatly affect gas turbine generator set operation. The one Paraho-II fuel refined to meet JP-5 specifications was low in smoke point, a result of the

TABLE 7. PROPERTIES OF SHALE-DERIVED JET FUELS

PROPERTIES		PARAHIO	GEOKINETICS		OCCIDENTAL		PARAHIO-11		IP-5
ASTM TEST METHOD	JP-4 MIL-T-5624-1 REQUIREMENTS	GC2-4 SAMPLE	IP-4 AL-9847-SP SAMPLE	IP-4 GC1-4 SAMPLE	IP-4 CONVENTIONAL	JP-5 AL-8436-F	JP-5	MIL-5624-L REQUIREMENTS	
Color, Saybolt	Report	NA	NA	NA	NA	NA	Report		
TAN, mg KOH/g	0.015 max	NA	0.01	NA	NA	0.0	0.015 max		
Aromatics, vol%	25.0 max	1.7	9.8	4.8	14.6	22	25.0 max		
Olefins, vol%	5.0 max	0.4	0.6	0.7	1.3	2	5.0 max		
Mercaptan sulfur, wt%	0.001 max	NA	0.0001	NA	0.0001	NA	0.001 max		
Sulfur, wt%	0.4 max	NA	0.004	NA	0.0003	0.005	0.4 max		
Distillation, °C									
IBP	Report	NA	NA	NA	NA	174	Report		
10% recovered	14.5 max	109	128	109	NA	189	205 max		
20% recovered	190 max	141	147	124	127	192	Report		
50% recovered	245 max	182	222	187	172	202	Report		
90% recovered	270 max	211	266	211	232	228	Report		
End point	1.5 max	1.0	1.5	1.4	275	248	280 max		
Residue, vol%	1.5 max	1.0	0.0	1.0	NA	1.5	1.5 max		
Loss, vol%	1.5 max	1.0	0.0	1.0	NA	0.0	1.5 max		
Explosiveness, %	NR	NA	NA	NA	NA	NA	50 max		
Flash point, °C	Method, 1151	NR	NA	NA	NA	62	60 min		
Density, kg/l : 15°C	D 93	0.751-0.802	0.762	0.7845	0.776	0.8081	0.788-0.845		
Vapor pressure : 37.4°C, kPa	D 1298	14-21	15	11.2	11	NA	NR		
	D 323 or D 2551	-58 max	-69	-56	-68	-58	NR		
Freezing Point, °C	D 2386	NR	NA	NA	NA	4.69	8.5 max		
Viscosity : -20°C, cSt	D 445								
Net heat of combustion, MJ/kg	D 1405, D 2404, D 2482	42.8 min	43.8	44.7	43.7	43.4	42.6 min		
Hydrogen content, wt%	D 1918 or D 3701	13.6 min	14.9	14.27	14.6	14.16	13.5 min		
Smoke point, mm	D 1322	20 min	NA	NA	NA	17.5	19.0 min		
Copper strip corrosion	D 130	18 max	NA	18	NA	1-	18 max		
2 hr. : 100°C	D 3241	25 max	NA	0.0	NA	0.0	25 max		
Change in pressure drop, mmHg	D 3241	3 max	NA	4	NA	1	4 max		
Preheater deposit code	D 381	7.0 max	NA	2.6	NA	0.0	7.0 max		
Existent gum, mg/100 ml	D 2276	1.0 max	NA	0.63	NA	0.3	1.0 max		
Particulate matter, mg/l	D 2276	15 max	NA	NA	NA	NA	NR		
Filtration time, min.	D 1094	18 max	NA	16	NA	NA	18 max		
Water reaction, interface rating	D 2550	85 min	NA	NA	NA	NA	85 min		
Modified water separation index	FED, STD, 791								
Fuel system icing inhibitor, vol%	Method, 5327	0.1 min	NA	NA	NA	NA	0.1 min		
Fuel icing inhibitor, vol%	D 2624 or D 3114	0.15 min	NA	NA	NA	NA	0.15 min		
Electrical conductivity, pS/m		200-600	NR	NA	NA	NA	NR		

NR = not required
NA = not available

low hydrogen/high aromatic content of the fuel.(17) This can cause soot formation in the combustor section of the engine, which in turn causes increased combustor liner temperatures and reduces the life of the combustor liner due to low-cycle thermal fatigue.(16) The high copper strip corrosion is undesirable and indicates possible fuel system corrosion problems.

All fuels tested met the aromatic content specifications for JP-4 and JP-5. This will probably be true for most shale fuels because of the hydrotreatment necessary to meet thermal stability requirements. The hydrogenation process produces increased naphthene content and possible peroxide formation. Again, the effect of naphthenes on elastomers is largely unknown and may cause long-term compatibility problems. All fuels tested met sulfur content specifications. The copper strip corrosion of the Paraho-II JP-5 (this may have been caused by an isolated refining error) indicates that corrosion problems could manifest themselves with this fuel. Viscosities of the fuels are probably acceptable as indicated by the correct boiling point distributions. Very little data are available on the stability of shale-derived jet fuels. Those existent gum tests reported in Table 7 were acceptable, and adequate hydrotreatment should make shale fuels sufficiently stable for generator set use. Again, data on contaminants are scarce but values reported were acceptable.

Fuel systems on gas turbine generator sets generally consist of a tank, primary filter, fuel pump, governor, metering valves, atomizer, and associated fuel lines. Items that rely on fuel for lubrication are the fuel pump and governor. There have been some lubricity-related problems in the TF30 aircraft engines. The fuel control units and afterburner fuel pumps failed due to the low lubricity of a petroleum-derived fuel. The problem was corrected by adding a corrosion inhibitor which also acts as a lubricity improver.(16) The Garrett Turbine Engine Company (AiResearch) was queried about fuel lubricity in their engines. Garret stated that they had not conducted any shale fuel tests but had expended extensive efforts to extend the service life of fuel controls with normal fuels.(38)

BOCM test results are shown in Table 4 for Paraho JP-8, Paraho JP-5, and Geokinetics JP-4.(28) Unfortunately, no petroleum-based JP-4, JP-5, or JP-8 were tested. Because of this, it is difficult to make quantitative predictions as to the lubricity of the shale fuels in relation to their petroleum counterparts. According to the best definition of lubricity available,(39) the Paraho JP-8 and the Geokinetics JP-4 rank as "good" while the Paraho JP-5 ranks "poor" based on wear scar diameters.

Moses, et al. state that shale-derived JP-5 requires moderate to high severity hydrogenation to remove nitrogen and to increase hydrogen content. Thermal stability and oxidation stability are potential problems. The hydrogenation process will probably produce low lubricity, low conductivity, and potential peroxide formation, but these potential problems can be controlled by fuel additives.(16)

No tests of shale-derived fuels in gas turbine generator sets were discovered during the course of this investigation. There are, however, results of several full-scale and combustor studies presented herein that utilize shale fuels in gas turbine engines. The first full-scale test was conducted using Paraho-I JP-5 in a TF34-GE-2 engine by the Naval Air Propulsion Test Center (NAPTC) in 1975. Three six-hour, ten-level endurance cycles were completed. Testing of the fuel was stopped because of insufficient test fuel and a nonfuel-related engine problem. The test fuel contained high levels of contaminants and was filtered four times to make it suitable for testing. Conclusions of the test were that engine performance and operation were comparable to that obtained with petroleum JP-5 but that more testing was necessary to determine the fuel's suitability as an aircraft fuel.(15)

Another full-scale test was performed using Paraho-I JP-4 in an Air Force T39 executive jet in 1975. The aircraft, which uses two P&W J-60 engines, was fueled with clay-treated shale-derived JP-4 fuel and flown from Wright Patterson AFB, Dayton, Ohio, to Carswell AFB, Fort Worth, Texas. The aircraft refueled at Carswell AFB with conventional JP-4 and accomplished the return flight with a 44-percent shale/56-percent petroleum JP-4 fuel. There was no problem with the fuel, and the performance of the aircraft was identical to that expected with conventional JP-4.(15)

A combustor from a T-63 jet engine was used to test the combustion of Paraho-II JP-5 and DFM at the AFLRL in 1980. The combustion properties of the shale fuels were not significantly different from respective petroleum-derived fuels. Carbon monoxide and NO_x emissions were essentially the same for the shale fuels and the petroleum-derived Jet A fuel. This same study concluded that the Paraho-II JP-5 and DFM were compatible with petroleum-derived fuels.(32)

In 1979, SwRI studied the sensitivities of gas turbine combustors to the physical and chemical properties of fuels. Eighteen fuels, including one sample of Paraho-II JP-5, were burned in a Phillips 2-inch combustor and a T-63 combustor. Gaseous emissions and combustion efficiency were not significantly affected by fuel properties, although some sensitivity to boiling point distribution was evident. Potential problems include increased smoke for some engines if hydrogen content is reduced, and increased ignition requirement for fuels with higher flash points in cold weather.(40)

In 1975, a combustion test was performed using Paraho-I JP-5 in a CF6-50 full annulus combustor. At idle conditions, emissions for the shale JP-5 were similar to those obtained from petroleum-derived JP-5 with the exception of higher NO_x emissions for the shale fuel. At takeoff conditions, emissions were the same for shale fuel and petroleum fuel. Liner temperatures were independent of fuel. It should be noted that the as-received fuel had a high concentration of particulate matter and it was necessary to filter the fuel through 25- and 7-micrometer filters prior to testing.(15)

Most gas turbine generator sets specify VV-F-800C fuels as primary or alternate fuels. In general, shale diesel fuels can be expected to perform the same as their petroleum-derived counterparts in this service. The same temperature limitations will apply. Generator sets designed to operate on JP-4 and diesel fuels could operate successfully on low-lubricity diesel fuel due to the higher viscosity of diesel fuels than JP-4.

IV. CONCLUSIONS

A. Gasoline Engines

Shale fuel properties of concern for gasoline engines are summarized in Table 8. Special care must be taken by refiners and DOD procurement personnel to ensure that octane number, oxidation stability, Reid vapor pressure, water and sediment, and sulfur content are within MIL-G-3056D or

TABLE 8. SHALE FUEL PROPERTIES OF CONCERN FOR GASOLINE ENGINES

<u>Fuel Property</u>	<u>Area of Concern</u>	<u>Potential Resolution</u>
Octane Number	Decrease causes poor performance, poor life	Control by specification, test by 640.1C (maximum power) and 690.1C (endurance)*
Reid Vapor Pressure	High RVP causes vapor lock while low RVP causes difficult cold starting	Control by specification, test by 710.1C (high temperature) and 701.1C (extreme cold starting and operating)
Water & Sediment	High water and sediment causes filter pluggage and poor performance	Control by specification
Sulfur content	High sulfur content causes decreased engine life, high emissions and elastomer degradation	Control by specification
Aromatic content	High aromatic content causes elastomer degradation and decreased engine life	Monitor & record, test by 690.1C (endurance)
Oxidation stability	Low oxidation stability causes poor performance and difficult starting	Control by specification

*Test numbers refer to procedures from MIL-STD-705B Generator Sets, Engine Driven, Methods of Tests and Instructions(33)

VV-G-001690A specifications. Aromatic content of shale fuels is also of concern and should be less than 45 percent by volume to avoid elastomer degradation (particularly with Buna-N compounds). Procedures for operational verification are not contained herein due to the fact that shale gasolines are not available for testing.

Based on contacts with industry, known shale fuel properties, and limited engine tests, current DOD gasoline-powered generator sets can operate satisfactorily on shale fuels.

B. Diesel Engines

Shale fuel properties of concern for diesel engines are summarized in Table 9. BOCM test results, information from engine manufacturers, and past tests indicate that lubricity will be a small problem if it turns out to be a problem at all. Indeed, only fuel systems with borderline lubrication will be affected by the reduced lubricity of the shale fuels. If lubrication problems do occur in a significant number of fuel systems, then lubricants may be added to control the problem. Fuel system bench tests and/or endurance tests should indicate any initial problems.

Not enough is known about the effects of naphthenes on the elastomers used in generator sets to make quantitative statements about long-term effects on generator set operation. Fuel system bench tests and/or endurance tests may give indications of elastomer distress. Cetane number is, of course, controlled by specifications. Inspection properties of existent shale fuels and past engine tests indicate that cetane number will probably not be a problem. The extreme cold start test and maximum power test should eliminate any cetane-related performance doubts about the shale fuels tested. Cloud point is also controlled by specifications. Inspection properties indicate that shale fuels can be produced to meet cloud point specifications. The extreme cold start test will reveal any cloud point problems as plugged filters and failure to start.

TABLE 9. SHALE FUEL PROPERTIES OF CONCERN FOR DIESEL ENGINES

<u>Fuel Property</u>	<u>Area of Concern</u>	<u>Potential Resolution</u>
Lubricity	Low lubricity causes pump wear, poor performance, decreased engine life.	Test by fuel system bench and/or 690.lC (endurance)*
Naphthene content	Effect of naphthenes on elastomers largely unknown, possible elastomer degradation and decreased engine life.	Test by fuel system bench tests and/or 690.lC (endurance).
Cetane Number	Low cetane number causes poor performance, poor startability, decreased engine life.	Control by specification, test by 701.lC (extreme cold starting) and 640.lC (maximum power)
Cloud point	High cloud point causes poor cold weather performance and startability.	Control by specification, test by 701.lC (extreme cold start)
Volatility	Low volatility causes poor atomization and poor performance, high volatility causes vapor lock, poor starting, pump wear and decreased engine life.	Control by specification, test by fuel system bench tests, 710.lC (high temperature), 701.lC (extreme cold), 720.lC (altitude), 690.lC (endurance)
Viscosity	High viscosity causes poor atomization and poor performance, low viscosity causes pump wear and decreased engine life.	Control by specification, test by fuel system bench tests, 710.lC (high temperature), 701.lC (extreme cold), 720.lC (altitude), 690.lC (endurance)
Sulfur content	High sulfur content causes engine corrosion, deposits, decreased engine life.	Control by specification
Water and sediment	High water and sediment cause filter pluggage, poor performance, decreased engine life.	Control by specification
Carbon residue	High carbon residue contributes to deposits, poor performance, decreased engine life.	Control by specification, test by 690.lC (endurance).
Stability	Low stability causes filter pluggage, poor performance, decreased engine life, poor startability.	Control by specification

*Test numbers refer to procedures from MIL-STD-705B, Generator Sets, Engine Driven, Methods of Tests and Instructions.(33)

Volatility and viscosity for diesel fuels are closely linked. Based on inspection properties and successful runs in a variety of engines, it appears that shale fuels can deliver the proper viscosity and volatility for Army generator sets. Increased fuel viscosity (up to specification limits) should offset any potential lubricity problems. Sulfur content was acceptable in all fuels tested. This will probably not be a problem due to the refining process for shale fuels. Adequate refining seems to have brought water and sediment into acceptable ranges in the latest shale fuels.

Carbon residue does not seem to have caused a problem in the engine tests reported herein. There are very little inspection property data upon which to base a prediction. This property is controlled by specification and can be tested in the endurance test.

Shale fuels tested to date have run the gamut from poor (Paraho-I fuels) to good (Paraho-II fuels). As experience in refining shale fuels grows, high quality shale fuels repeatably produced can be expected. Adherence to existing specifications and an adequate test program should ensure successful generator set operation on shale diesel fuels.

Some generator set testing will be necessary in order to assess the short- and long-term effects of shale fuel use. A recommended test procedure was included in the recommendations section of this report in order to facilitate this.

C. Gas Turbine Engines

Shale fuel properties of concern for gas turbine engines are summarized in Table 10. The low lubricity of shale fuels (relative to comparable petroleum fuels) is not expected to cause a problem. Again, only fuel systems with marginal lubrication would be adversely affected. Lubricating additives should control any wear problems detected by a fuel system bench test and/or endurance test.

TABLE 10. SHALE FUEL PROPERTIES OF CONCERN FOR GAS TURBINE ENGINES

<u>Fuel Property</u>	<u>Area of Concern</u>	<u>Potential Resolution</u>
Lubricity	Low lubricity causes pump wear, poor performance, decreased engine life.	Test by fuel system bench tests and/or 690.lC (endurance)*
Naphthene content	High naphthene content may cause elastomer degradation, decreased engine life.	Test by fuel system bench tests and/or 690.lC (endurance).
Freezing point	High freezing point causes filter plugging and poor starting at cold temperatures	Control by specification, test by 701.lC (extreme cold start)
Volatility	Low volatility causes difficult starting in cold temperatures.	Control by specification, by fuel system bench tests, 710.lC (high temperature), 701.lC (extreme cold), 720.lC (altitude)
Viscosity	High viscosity causes low temperature pumpability problems, low viscosity causes pump wear and decreased engine life	Control by specification, test by fuel system bench tests, 701.lC (extreme cold start), 690.lC (endurance).
Sulfur content	High sulfur content causes engine corrosion, high emissions, decreased engine life.	Control by specification, test by fuel system bench test and/or 690.lC (endurance)
Hydrogen content	Low hydrogen content may cause increased combustor liner temperature, decreased engine life	Control by specification, test by 690.lC (endurance)
Aromatic content	High aromatic content causes increased combustor liner temperature, decreased engine life.	Control by specification, test by 690.lC (endurance)
Contaminants	High contaminants cause filter pluggage, pump wear, decreased engine life, hard starting	Control by specification
Stability	Low stability causes filter pluggage, difficult starting, decreased engine performance	Control by specification

*Test numbers refer to procedures from MIL-STD-705B, Generator Sets, Engine Driven, Methods of Tests and Instructions.(33)

High aromaticity is not expected in shale jet fuels, due to the specifications and the hydrotreating necessary to remove nitrogen compounds. This hydrotreating converts aromatics to naphthenes. The effect of naphthenes on fuel system elastomers is largely unknown. The fuel system bench tests and/or endurance tests should give indications of any problems in this area.

The freezing point of jet fuels is controlled by specification. No problems are expected with freezing points due to the proven ability of refiners to meet freezing point specifications. The extreme cold start test should reveal any problems with freezing point and/or wax formation.

Volatility and viscosity are closely related and well specified. No major problems are expected in this area due to the ability of refiners to meet specifications and the success of several combustor and engine tests. In addition, gas turbine engines are very fuel tolerant, and minor changes in volatility and viscosity are not expected to adversely affect performance. Increases in viscosity would effectively counteract any low lubricity tendencies of the fuels. Pertinent tests for volatility are high-temperature starting, altitude operation, and extreme cold start. Tests for viscosity include the fuel system bench test, extreme cold start, and endurance.

Sulfur content is again controlled by specification. Existent shale fuels met sulfur specifications easily (although some copper strip corrosion was noted with one fuel). Any significant problems in this area should be revealed in the fuel system bench tests and/or endurance tests.

The low hydrogen content of many shale fuels may cause increased smoke, increased combustor liner temperatures and poor life (due to low-cycle thermal fatigue in the combustion can liners). Generator sets undergoing cyclic or intermittent loading would be expected to experience more combustor can liner failures than units subjected to constant loading. The endurance test would provide an indication of potential problems if combustion can liners of shale and petroleum-fueled generator sets were compared at test completion.

Contaminants are controlled by specifications and fuel-handling practices. Contaminants do not appear to be a problem.

Stability of shale fuels will to a large extent be determined by the degree of hydrotreating they receive. Existent specifications for preheater deposit code and existent gum should adequately limit the stability of shale fuels.

Existent shale fuels show that refineries have the capabilities to produce military specification shale fuels. Adherence to existing specifications and an adequate test program should ensure successful generator set operation on shale fuel. A recommended test procedure is presented in the next section. A list of engine and component tests summarized herein is presented in Table 11.

TABLE 11. SUMMARY OF ENGINE AND COMPONENT TESTS

<u>Fuel</u>	<u>Component</u>	<u>Reference</u>
Paraho-I Gasoline	L-141 Engine	14
Paraho-I Gasoline	L-141 Engine	15
Shale JP-4, JP-8	Elastomers	16
Paraho-II DFM, JP-5, JP-8, Geokinetics JP-4	BOCM Tests	28
Paraho-II DFM	LDT-465-1C F.I. Pump	29
Paraho-I DF-2	Onan DJB Gen. Set	15
Paraho-I DFM	Cummins NTCC-350 Engine	31
Paraho-I DFM	DD 3-71 Engine	15
Paraho-II DFM	DD 6V-53T and 3-53T Engines	32
Paraho-II DFM	DD 3-53T Engine	33
Paraho-II DFM	EMD Test Engine	34
Paraho-II DFM	Single-Cylinder Test Engine	35
Paraho-I JP-5	TF34-GE-2 Engine	15
Paraho-I JP-4	T-39 Aircraft	15
Paraho-II JP-5	T-63 Combustor	32
Paraho-II JP-5	Phillips 2 in. Combustor and T-63 Combustor	40
Paraho-I JP-5	CF6-50 Combustor	15

V. RECOMMENDATIONS

The generator sets underlined in Appendices B and D are recommended for testing. Engines for these generator sets are underlined in Table 1. This selection of generator sets is based on the following criteria:

1. Selection of one engine from each of the major fuel systems used on Army generator sets (A, B, C, etc., in Table 1).
2. Selection of engines with the lowest kW rating (to minimize fuel costs).

Since no data are accessible regarding the availability of generator sets, recommendations have been presented in a format that lends itself to substitution. If a particular generator set is not available, any generator set under that heading (A, B, C, etc.) in Table 1 may be selected. Again, kW rating will determine the fuel cost of the test.

Ideally, fuel system bench tests should precede full-scale engine testing. Such testing would consist of two identical fuel systems (pumps, injectors, filters, and lines) from each of the above engines, driven by one variable speed AC motor by rubber cog belts at normal injector pump speed. One pump would utilize petroleum DF-2 and the other, the shale fuel. Fuel supplies should be large storage tanks with the test fuels being recycled or fed on to engine testing. If recycled, the fuels should be checked periodically and clay filtered to a constant lubricity. Operating cycle for these tests would be nine seconds full rack followed by one second idle. Duration of the tests would be the endurance time specified in the procurement document for that particular generator set. Delivery of rated flow and correct spray pattern by both fuels at the end of the test would constitute successful completion. Failure of both fuels would indicate a too severe test. Any failure of shale fuel should be repeated as a guard against experimental error.

Full-scale generator set testing should follow the procedures outlined in MIL-STD-705B.(41) Generator sets passing the bench tests should be run with shale fuel in the following MIL-STD-705B procedures:

- 608.1a Frequency stability and transient response (short-term)
- 710.1c High temperature
- 720.1c Altitude
- 701.1c Starting and operating (extreme cold)
- 640.1c Maximum power (run last)

Generator sets failing the extreme cold starting test should be run through the 701.2c (moderate cold) procedure as well. Any failures with the shale fuels should be repeated with petroleum fuel in the same generator set to determine if the problem is fuel or engine related. In all cases, pass/fail criteria should be obtained from the procurement document for the generator set in question. Generator sets not run through the bench tests should run procedure 690.1c (endurance) in addition to the above tests. No test procedures for gasoline-powered generator sets are presented because shale gasolines are not available for testing. Shale fuels which differ widely from DF-2 (in either specification or nonspecification properties) would be the most desirable fuels to test. This "worst case" philosophy would minimize both the time and money necessary to qualify shale fuels for generator set service. A flow chart for the recommended test procedure is presented in Figure 2.

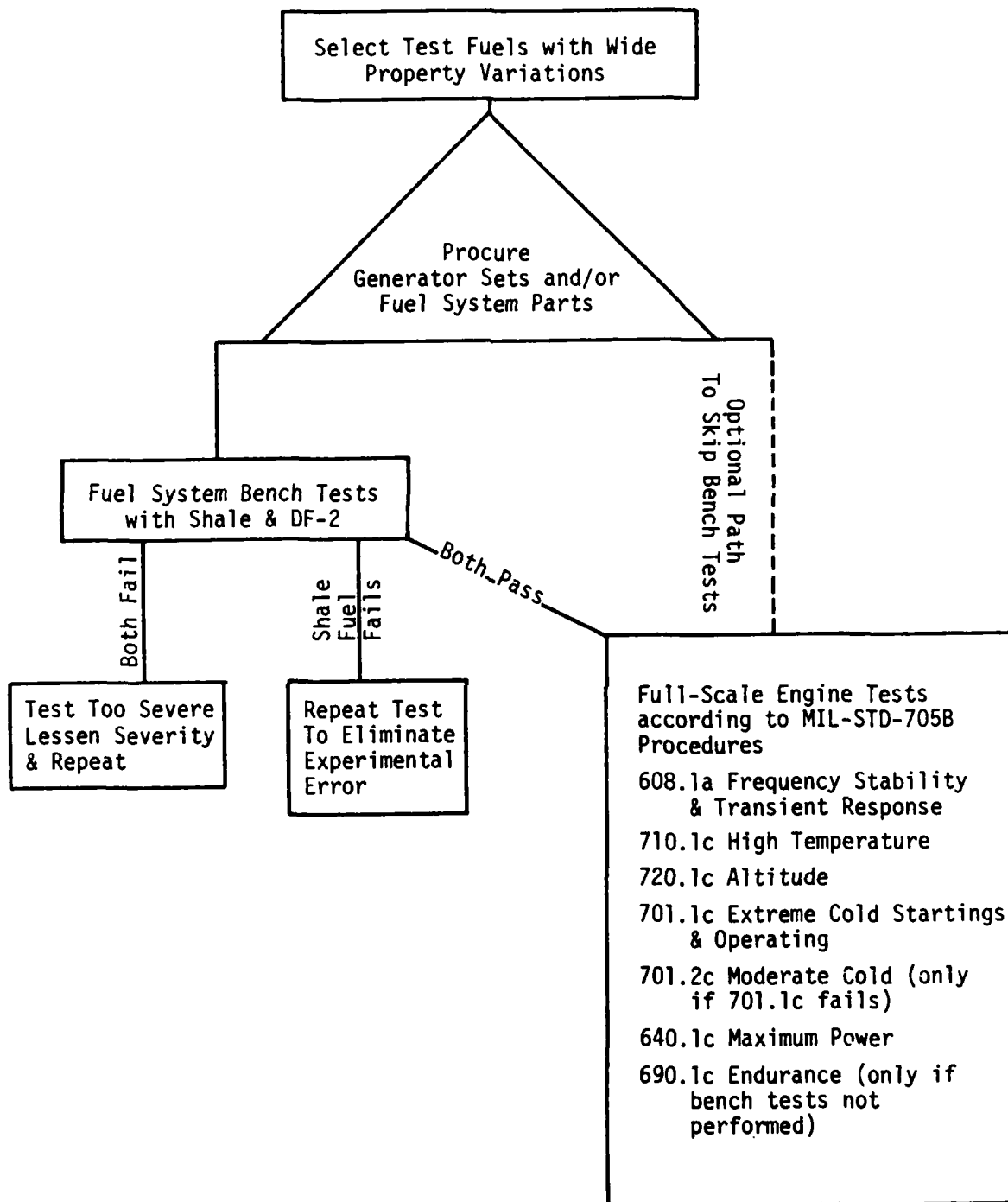


FIGURE 2. RECOMMENDED TEST PROCEDURE

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APPENDIX A

GENERATOR SETS, POWER PLANTS, AND POWER UNITS
BY NATIONAL STOCK NUMBER

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4.2

GENERATOR SETS, POWER PLANTS AND POWER UNITS BY NATIONAL STOCK NUMBER

NSN	DESCRIPTION	ENGINE
6115000162356	GEN ST DED 45KW 400HZ MTD PU614/M	CUMMINS JS-G/S/S52300
6115000178236	GEN ST 1.5KW 28V MEP025A	MIL STD 2A016-1,2,3
6115000178237	GEN ST 3KW 60HZ MEP016A	MIL STD 4A032-1,2
6115000178238	GEN ST 3KW 400HZ MTD MEP021A	MIL STD 4A032-1,2
6115000178239	GEN ST 3KW 28V MTD MEP026A	MIL STD 4A032-1,2
6115000178240	GEN ST 5KW 60HZ MEP 017A	MIL STD 2A042 2,3
6115000178241	GEN ST 5KW 400HZ MEP022A	MIL STD 2A042 2,3
6115000229656	GEN ST DED 150KW 60HZ LAT D353PR PWR	CATERPILLAR TRAC D333
6115000331373	GEN ST DED 5KW 60HZ PU751/M	ONAN DIV DJE-99/9485
6115000331389	GEN ST DED 10KW 60HZ PU753/M	ONAN DIV DJF-99/9487
6115000331395	PWR PLT DED 5KW 60HZ AN/MJQ-16	ONAN DIV DJE-99/9485
6115000331398	PWR PLT DED 10KW 60HZ AN/MJQ-18	ONAN DIV DJF-99E/9487
6115000567906	PWR PLT 30KW 60HZ AN/MJQ-10	DETROIT DIESEL 5033-7101
6115000568421	GEN ST 10KW 400HZ MTD PU304C/MPQ-4A	MIL STD 4A084-11
6115000595172	GEN ST 5KW 60HZ MTD PU631/G	MIL STD 2A042-2,3
6115000746396	GEN ST 7.5KW 28V MTD HLSWTH JHGV7.5A	WISCONSIN MOTOR MVH4D
6115000746442	GEN ST GT 750KW 60HZ GTE PU697/M	SOLAR T-1020 S-39
6115000751638	GEN ST 3KW 400HZ CON HF-30-MD	MIL STD 4A032-1,2
6115000751639	GEN ST GT 30KW 400HZ GTGE 70-6-1	AIRESEARCH GTP70-50
6115000759122	GEN ST DED 45KW 60HZ HLSWTHDW45A	CONTINENTAL MTRS TD427
6115000759123	GEN ST 2KW 12V EGLE CE228	CLINTON 416-1300
6115000778598	GEN ST 5KW 400HZ HOLGAR CE57400C	WISCONSIN MOTOR MTHDE
6115000778600	GEN ST DED 30KW 60HZ HOLG CE301ACWK1	DETROIT DIESEL 5033-7101
6115000812030	GEN ST DED 100KW 60HZ MIL26727	CUMMINS ENGINE NH-220-BI
6115000870873	GEN ST 3KW 60HZ MTD PU628/G	MIL STD 4A032-1,2
6115000870972	GEN ST 3KW 60HZ MTD PU626/G	MIL STD 4A032-1,2
6115000895099	GEN ST DED 15KW 400HZ HOLGAR SPHF-15	HERCULES ENGINE D198ER
6115001181240	GEN ST DED 30KW 60HZ MEP 005A	HERCULES ENG D298-ERX37
6115001181241	GEN ST DED 15KW 60HZ MEP004A	HERCULES ENG D198-ERX51
6115001181243	GEN ST DED 60KW 60HZ MEP006A	ALLISCHALMERS 3500
6115001181244	GEN ST DED 15KW 400HZ MEP113A	HERCULES ENG D198-ERX51
6115001181245	GEN ST DED 15KW 60HZ MEP 103A	HERCULES ENG D198-ERX51
6115001181247	GEN ST DED 30KW 60HZ MEP104A	HERCULES ENG D298-ERX37
6115001181248	GEN ST DED 30KW 400HZ MEP114A	HERCULES ENG D298-ERX37
6115001181252	GEN ST DED 60KW 60HZ MEP105-A	ALLIS CHALMERS 3500
6115001181253	GEN ST DED 60KW 400HZ MEP115A	ALLIS CHALMERS 3500
6115001257876	GEN ST DED 60KW 60HZ PU700M	CUMMINS ENGINE C 180B1
6115001263024	GEN ST GT 60KW 400HZ MEP404A	SOLAR TITAN
6115001320488	GEN ST DED 60KW 60HZ PU699/M	CUMMINS ENGINE C 180B1
6115001339101	GEN ST DED 100KW 60HZ MEP 007A	CATERPILLAR TRAC D333C
6115001339102	GEN ST DED 100KW 60HZ MEP106A	CATERPILLAR TRAC D333C
6115001339103	GEN ST DED 100KW 60HZ MEP116A	CATERPILLAR TRAC D333C
6115001339104	GEN ST DED 200KW 60HZ MEP 009A	CATERPILLAR TRAC D334T
6115001340825	POWER UNIT GT UTIL (MUST) PPU85-4	AIRESEARCH GTCP85-127
6115001348485	PWR PLT DED 200KW 60HZ MTD AN/MJQ-11	ALLIS CHALMERS 25000
6115001564342	GEN ST DED 100KW 60HZ JTA D8001M	ALLIS CHALMERS 11000
6115001653842	PWR PL UTIL PU-71	AIRESEARCH GTCP85-127
6115001677468	PWR PLT 60KW 60HZ AN/MJQ-14	ALLIS CHALMERS 3500
6115002203878	GEN ST DED 60KW 60HZ PU650A/G	CUMMINS ENGINE C 180B1
6115002250142	GEN ST 0.4KW 400HZ ADMIRAL PU422	BRIGGS & STRATTON 60432

6115002261568	GEN ST 10KW 400HZ BOGUE 5380B	WISCONSIN MOTOR MVH4D
6115002408729	GEN ST 0.4KW 400HZ 909238-1A	BRIGS & STRATTON 60432
6115002504402	PWR PLT DED 4500KW 60HZ	GMC ENGINE 16576E-4
6115002504403	PWR PLT ELEC DED 4500KW 60HZ	GMC ENGINE 16576E-4
6115002504404	PWR PLT DED 1500KW 60HZ	CATERPILLAR TRAC D398
6115002504405	PWR PLT DED 2000KW 60HZ	CATERPILLAR TRAC D398
6115002571602	PWR PLT AN/MJQ-12A	CUMMINS C 180B1
6115002581622	GEN ST DED 60KW 60HZ PU650BG	HERCULES ENG D198ERX51
6115002603082	GEN ST DED 15KW 400HZ PU732/M	HERCULES ENG D198ERX51
6115003015761	GEN ST DED 100KW 60HZ CONSOL DSL 418	CONTINENTAL MTRS SD802
6115003949573	GEN ST DED 60KW 400HZ PU707A/M	CUMMINS C180B1
6115003949575	GEN ST DED 100KW 60HZ PU495A/G	CATERPILLAR TRAC D333C(T
6115003949576	GEN ST DED 30KW 60HZ PU406B/B	HERCULES ENG D298-ERX37
6115003949577	GEN ST DED 15KW 60HZ PU405A/M	HERCULES ENG D198-ERX51
6115003949581	GEN ST DSL 30KW 400HZ MTD PU760/M	HERCULES ENG D198ERX37
6115003949582	PWR PLT DED 30KW 60HZ AN/MIQ-10A	HERCULES ENG D198ERX37
6115003949583	PWR PLT DED 200KW 60HZ AN/MJQ-11A	CATERPILLAR TRAC D334T
6115004007591	PWR PLT ELEC AN/MJQ-15	HERCULES D198
6115004364228	GEN ST DED 200KW 60HZ WAUKESHA E812	WAUKESHA F1905 DSV-E812
6115004364230	GEN ST 0.3KW 400HZ PU 532PPS4	BRIGGS & STRATTON 60432
6115004505881	GEN ST DED 750KW 60HZ MEP208A	CUMMINS KTA2300-G
6115004644194	PWR PLT 60KW 60HZ AN/MJQ-12	CUMMINS ENGINE C 180 B 1
6115004644195	GEN ST DED 60KW 400HZ PU 707/M	CUMMINS ENGINE C 18031
6115004651030	GEN ST DED 10KW 60HZ MEP003A	ONAN DIV DJF-99E/9487
6115004651044	GEN ST DED 5KW 60HZ MEP002A	ONAN DIV DJE-99E/9485
6115004756573	GEN ST DED 45KW 400HZ SSMDL 52300	STEW&STVS SERV 3045C
6115004765878	GEN ST DED 500KW 60HZ MEP011A	CUMMINS VTA-1710G
6115004859207	GEN ST 3KW 28V MTD PU666/G	MIL STD 4A032-1,2
6115005426011	GEN ST DED 45KW 60HZ CUMJSGA601-45A	CUMMINS ENGINE JIS 600
6115005426012	GEN ST DED 45KW 400HZ CUMJSGA601-45	CUMMINS ENGINE JIS 600
6115005578744	GEN ST DED 45KW 400HZ S AND S 26200	STEW&STVS SERV 4045C
6115005605290	GEN ST 5KW 60HZ HOLGAR CE56AC	WISCONSIN MOTOR MTHDE
6115005778471	GEN ST GAS ENG TM PU332/U	MIL STD 4A084-11
6115005916866	GEN ST DED 15KW 60HZ WINPWR D15H18Z	HERCULES ENG DD-198
6115005916867	GEN ST 1.5KW 60HZ KHLR KK15M25	MIL STD 2A016-1,2,3
6115006003404	GEN ST DED 150KW 60HZ WA6NKDBS EU1PR	WAUKESHA MOTOR 6NKDBS4N
6115006069693	GEN ST DED 15KW 60HZ US10327BA	US MOTORS HD260
6115006069985	GEN ST DED 60KW 60HZ SZDLYENG-501	CONTINENTAL MTRS RD572
6115006081614	GEN ST DED 60KW 60HZ CUM JS6G60KW-A	CUMMINS ENGINE JIS600
6115006200616	GEN ST DED 60KW 60HZ HOLG CE600ACEG	CONTINENTAL MTRS SD802
6115006204075	GEN ST DED 45KW 400HZ S AND S 28100	STEW&STVS SERV 3045C
6115006240385	GEN ST DED 45KW 400HZ CONSOL DSL 406	CONTINENTAL MTRS TD427
6115006242767	GEN ST DED 100KW 60HZ JTAMD1001815WW	ALLIS CHALMERS 11000
6115006242768	GEN ST DED 60KW 60HZ JTA MD601815W	JETA METAL FABR D-516
6115006279031	GEN ST DED 15KW 60HZ WPWR0-15H 18M	WINPOWER MFG DD198
6115006281243	GEN ST 5KW 60HZ HOLGAR CE55ACWK6	CONTINENTAL MTRS VS69
6115006352529	GEN ST DED 150-165KW 60HZ NHRSGA601	CUMMINS ENGINE NHR5-600
6115006356636	GEN ST 0.5KW 28V HMLTE 5D28-23A	HOMELITE A 54770
6115006434674	GEN ST 10KW 400HZ MTD PU304	MIL STD 4A084-11
6115006466122	GEN ST 1.5KW 28V PNR GEMTRCE15L	MIL STD 2A016-1,2,3
6115006535634	GEN ST DED 15KW 60HZ JTA151815WWINT	HERCULES ENGINE DD198
6115006787794	GEN ST DED 30KW 60HZ 30US16936WINT	CONTINENTAL MTRS JD403
6115006908290	GEN ST 10KW 60HZ PAC MER PM5901	CONTINENTAL MTRS FS162
6115006934850	PWR PLT 45KW 60HZ AN/MJQ-4	CONTL MTR TD427-2281

6115006972402	GEN ST GAS ENG TM PU253/U	CONTINENTAL MTRS FS162
6115007023347	GEN ST DED 45KW 60HZ PU407/M	CONTINENTAL MTRS TD427
6115007023348	GEN ST 5KW 60HZ TM PU409M	MIL STD 2A042-11
6115007080032	GEN ST DED 45KW 400HZ CUM JS-6-G	CUMMINS ENGINE JS-6-1G
6115007090469	GEN ST DED 45KW 60HZ PU408/M	CONTINENTAL MTRS TD427
6115007120422	GEN ST DED 30KW 60HZ JTA MD3018115WW	JETA METAL FABR DD298
6115007136647	GEN ST DED 150KW 60HZ CUM NVH12G1200	CUMMINS ENGINE NVH-12-G
6115007223760	GEN ST DED 15KW 60HZ PU402/M	DETROIT DIESEL 5033-7101
6115007267933	GEN ST 0.4KW 400HZ MIL-G-52373	MIL STD 1A08-1,2,3
6115007305911	GEN ST 0.5KW 60HZ AF50-1A08-2	MIL STD 1A08-1,2,3
6115007318191	GEN ST 3KW 60HZ SZEMCO 1021WIN	WISCONSIN MOTOR MAENLD
6115007386335	GEN ST 3KW 60HZ MTD PU617/M	MIL STD 4A032-1,2
6115007386336	GEN ST 10KW 60HZ MTD PU332A/G	MIL STD 4A084-2,3
6115007386337	GEN ST 5KW 60HZ MTD PU618/M	MIL STD 2A042 2,3
6115007386338	GEN ST 5KW 60HZ MTD PU409A/M	MIL STD 2A042 2,3
6115007386339	GEN ST 10KW 60HZ TM PU619/M	MIL STD 4A084-2,3
6115007386340	GEN ST 5KW 60HZ MTD PU 620/M	MIL STD 2A042-2,3
6115007386341	GEN ST 10KW 60HZ MTD PU564A/G	MIL STD 4A084-2,3
6115007386342	GEN ST DED 30KW 60HZ PU406/M	DETROIT DIESEL 5033-7101
6115007532231	GEN ST 10KW 400HZ MTD PU 375A/G	CONT MTRS FS162
6115007585492	GEN ST GT 50KW 400HZ GTGE 70-9-2	AIRESEARCH GTP70-50
6115007592768	GEN ST 2KW 12V HLSWTH JHGV2C	CLINTON 416-1300
6115007681780	GEN ST DED 30KW 60HZ CLEO 1 WINT	HERCULES ENG D198ER
6115007718107	GEN ST 0.5KW 60HZ G0536AS1A08-2	MIL STD 1A08-1,2,3
6115007749342	GEN ST 1.5KW 60HZ WIPM1536S2A016	MIL STD 2A016-1,2,3
6115007786004	GEN ST 3KW 60HZ HLSWTH JHGW3B	WISCONSIN MOTOR MAENLD
6115007786005	GEN ST 10KW 60HZ HOLGAR CE106ACWK9	CONTINENTAL MTRS FS162
6115007788788	GEN ST GT 30KW 400HZ GTGE70-1	AIRESEARCH GTP70-18-1
6115007877110	GEN ST DED 60KW 60HZ CUM JS66PR PWR	CUMMINS ENGINE JS-6-1G
6115007893655	GEN ST 10KW 400HZ MTD PU684/GLQ-3	MIL STD 48084-3
6115007893656	GEN ST 10KW 400HZ MTD PU681/TLQ-15	MIL STD 4A084-3
6115007922541	GEN ST DED 100KW 60HZ CONSOL DSL 411	CONTINENTAL MTRS SD802
6115007983444	GEN ST DED 100KW 60HZ GMC 6910A	DETROIT DIESEL 6045C
6115007990667	GEN ST 3KW 28V MTD GAMA-1	WISCONSIN MOTOR MAENLD
6115008165929	GEN ST 2KW 12V US MOT2US18086	WISCONSIN MOTOR MBKND
6115008174919	GEN ST DED 15KW 60HZ J151815WA	HERCULES ENGINE DD198ER
6115008232213	GEN ST DSL ENG 45KW 400HZ PU401/M	CONTINENTAL MTRS SD802
6115008232217	GEN ST DED 45KW 400HZ PU410/M	CUMMINS ENG J1S-600
6115008232218	GEN ST DED 100KW 60HZ PU495/G	MEP106A/CATD333C/GMC6910
6115008303758	GEN ST DED 60KW 60HZ LUMEN207	CUMMINS ENGINE NH-220-G
6115008331498	GEN ST 10KW 60HZ K AND R FERO-1	HERCULES ENG 1XB-3ER
6115008408258	GEN ST DED 45KW 60HZ CONSOL DSL 4150	CONSD DIESEL TD427
6115008460860	GEN ST DED 60KW 60HZ INTL MG0DTTSH6	CONTINENTAL MTRS RD572
6115008492323	GEN ST 1.5KW 28V WIPG1528T2A016	MIL STD 2A016-1,2,3
6115008496030	GEN ST GT 30KW 400HZ GTGE70-2W	A' ESEARCH GTP70-18-1
6115008559572	GEN ST 10KW 400HZ BOGUE 5380	WISCONSIN MOTOR MVH4D
6115008571397	GEN ST GAS ENG 4.2KW 28V	MIL STD 4A032-1,2
6115008602251	GEN ST 2KW 12V KECO EG-2	CLINTON 416-1300
6115008733915	GEN ST 3KW 60HZ MTD PU625/G	MIL STD 4A032-1,2
6115008878644	GEN ST 1.5KW 60HZ HOLGAR CE9115AC	MIL STD 2A016-1,2,3
6115008891212	GEN ST 0.3KW 400HZ PU 5321PPS4	BRIGGS & STRATTON 60432
6115008891307	GEN ST DED 45KW 60HZ PU551/M	CONTINENTAL MTRS TD427
6115008891446	GEN ST 1.5KW 60HZ MEP015A	MIL STD 2A016-1,2,3
6115008891447	GEN ST 10KW 40HZ MEP 018A	MIL STD 4A084-2,3

6115008961981	GEN ST 3KW 28V MTD HLSWTH JHGV3A	WISCONSIN MOTOR MAENLD
6115009031208	GEN ST 5KW 400HZ JETA MG5400	WISCONSIN MOTOR MTHDE
6115009034948	GEN ST 7.5KW 28V MTD BENDIX59B2-1A	WISCONSIN MOTOR MVH4D
6115009228690	GEN ST DED 15KW 60HZ BOGUE MDL 6113	HERCULES ENGINE D198ER
6115009234469	GEN ST 0.5KW 60HZ MEP014A	MIL STD 1A08-1,2,3
6115009260843	GEN ST 10KW 400HZ MEP023A	MIL STD 4A084-2,3
6115009268335	GEN ST 7.5KW 28V MTD BENDIX59B2-1B	WISCONSIN MOTOR MVH4D
6115009304240	GEN ST DED 60KW 60HZ AC3500-4472371	ALLIS-CHALMERS 3500
6115009309498	GEN ST 0.125KW 400HZ BM HMLTEXLA	HOMELITE A54770
6115009316789	GEN ST 10KW 400HZ MTD PU375B/G	MIL STD 4A084-111
6115009333498	GEN ST DED 100KW 60HZ HOLT BROSHB333	CATERPILLAR TRAC D333
6115009339983	GEN ST 0.15KW 60HZ SM BOGUE ELEC6150	HOMELITE XL-12
6115009355111	GEN ST DED 30KW 60HZ WESTHSESF30CIED	HERCULES ENG D298-ER
6115009358729	GEN ST DED 200KW 60HZ MEP108A	CATERPILLAR TRAC D334T
6115009370929	POWER UNIT GT UTIL (MUST) PPU85-5	AIRESEARCH GTCP85-127
6115009373523	GEN ST DED 10KW 60HZ LIBBY 148002-1	HERCULES ENGINE D198ER
6115009374388	GEN ST DED 60KW 60HZ 60DGFH22X6001A	CUMMINS ENGINE C180
6115009374389	GEN ST DED 60KW 400HZ 60DGFJ402X6002	CUMMINS ENGINE C180
6115009375046	PWR PLT 15KW 60HZ MTD AN/MJQ-9	HERCULES ENGINE D198
6115009375555	GEN ST 5KW 60HZ MTD PU629/G	MIL STD 2A042-2,3
6115009378468	GEN ST 10KW 400HZ MTD PU678/M	MIL STD 4A084-3
6115009407862	GEN ST 0.5KW 400HZ MEP019A	MIL STD 1A08-1,2,3
6115009407867	GEN ST 0.5KW 28V MEP024A	MIL STD 1A08-1,2,3
6115009498409	GEN ST DED 15KW 60HZ PU405/M	BOGUE 6113/HERCULES D198
6115009517442	PWR PLT 200KW 60HZ AN/MJQ-5	ALLIS CHALMERS 25000
6115009677005	GEN ST GT 30KW 400HZ MTD	AIRESEARCH GTP-70-18-1
6115009700006	GEN ST DED 45KW 60HZ S AND S 54400	STEW&STVS SERV 5043
6115009722326	GEN ST 10KW 400HZ BOGUE 5380A	WISCONSIN MOTOR MVH4D
6115009758381	GEN ST 3KW 60HZ HLSWTH JHGW3C	WISCONSIN MOTOR MAENLD
6115009758382	GEN ST 3KW 28V MTD HLSWTH JHGV3B	WISCONSIN MOTOR MAENLD
6115009768982	GEN ST DED 30KW 60HZ JTA MD3018115WA	JETA METAL FABR DD298H
6115009893296	GEN ST 10KW 400HZ MTD PU656/G	MIL STD 4A084-2,3
6115009909833	GEN ST DED 60KW 60HZ LUMEN2207PRLOP	CUMMINS ENGINE NH-220-G
6115009991899	GEN ST GT GE30-23	AIRESEARCH GTP30-40
6115009995935	GEN ST 7.5KW 28V MTD ATLAS POLMC111	WISCONSIN MOTOR MVH4D
6115009997901	GEN ST DED 200KW 60HZ ALLIS CH444465	ALLIS-CHALMERS 25000
6115010272342	GEN ST GT 10KW 400HZ D423A	SOLAR GEMINI
6115010306085	GEN ST DED 500KW 60HZ MEP029A	CUMMINS VTA-1710G
6115010366374	GEN ST DED 100KW 60 HZ MEP007B	CATERPILLAR TRAC 3306

APPENDIX B

GENERATOR SETS, POWER PLANTS, AND POWER UNITS
BY FUEL TYPE AND NSM

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GASOLINE POWERED GENERATOR SETS, POWER PLANTS AND POWER UNITS BY NSN

NSN	DESCRIPTION	ENGINE
6115000178236	GEN ST 1.5KW 28V MEP025A	MIL STD 2A016-1,2,3
6115000178237	GEN ST 3KW 60HZ MEP016A	MIL STD 4A032-1,2
6115000178238	GEN ST 3KW 400HZ MTD MEP021A	MIL STD 4A032-1,2
6115000178239	GEN ST 3KW 28V MTD MEP026A	MIL STD 4A032-1,2
6115000178240	GEN ST 5KW 60HZ MEP 017A	MIL STD 2A042 2,3
6115000178241	GEN ST 5KW 400HZ MEP022A	MIL STD 2A042 2,3
6115000568421	GEN ST 10KW 400HZ MTD PU304C/MPQ-4A	MIL STD 4A084-11
6115000595172	GEN ST 5KW 60HZ MTD PU631/G	MIL STD 2A042-2,3
6115000746396	GEN ST 7.5KW 28V MTD HLSWTH JHGV7.5A	WISCONSIN MOTOR MVH4D
6115000751638	GEN ST 3KW 400HZ CON HF-30-MD	MIL STD 4A032-1,2
6115000759123	GEN ST 2KW 12V EGLE CE228	CLINTON 416-1300
6115000778598	GEN ST 5KW 400HZ HOLGAR CE57400C	WISCONSIN MOTOR MTHDE
6115000870873	GEN ST 3KW 60HZ MTD PU628/G	MIL STD 4A032-1,2
6115000870972	GEN ST 3KW 60HZ MTD PU626/G	MIL STD 4A032-1,2
6115002250142	GEN ST 0.4KW 400HZ ADMIRAL PU422	BRIGGS & STRATTON 60432
6115002261568	GEN ST 10KW 400HZ BOGUE 5380B	WISCONSIN MOTOR MVH4D
6115002408729	GEN ST 0.4KW 400HZ 909238-1A	BRIGGS & STRATTON 60432
6115004364230	GEN ST 0.3KW 400HZ PU 532PPS4	BRIGGS & STRATTON 60432
6115004859207	GEN ST 3KW 28V MTD PU666/G	MIL STD 4A032-1,2
6115005605290	GEN ST 5KW 60HZ HOLGAR CE56AC	WISCONSIN MOTOR MTHDE
6115005778471	GEN ST GAS ENG TM PU332/U	MIL STD 4A084-11
6115005916867	GEN ST 1.5KW 60HZ KHLR KK15M25	MIL STD 2A016-1,2,3
6115006281243	GEN ST 5KW 60HZ HOLGAR CE55ACWK6	CONTINENTAL MTRS VS69
6115006356636	GEN ST 0.5KW 28V HMLTE 5D28-23A	HOMELITE A 54770
6115006434674	GEN ST 10KW 400HZ MTD PU304	MIL STD 4A084-11
6115006466122	GEN ST 1.5KW 28V PNR GEMTRCE15L	MIL STD 2A016-1,2,3
6115006908290	GEN ST 10KW 60HZ PAC MER PM5901	CONTINENTAL MTRS FS162
6115006972402	GEN ST GAS ENG TM PU253/U	CONTINENTAL MTRS FS162
6115007023348	GEN ST 5KW 60HZ TM PU409M	MIL STD 2A042-11
6115007267933	GEN ST 0.4KW 400HZ MIL-G-52373	MIL STD 1A08-1,2,3
6115007305911	GEN ST 0.5KW 60HZ AF50-1A08-2	MIL STD 1A08-1,2,3
6115007318191	GEN ST 3KW 60HZ SZEMCO 1021WIN	WISCONSIN MOTOR MAENLD
6115007386335	GEN ST 3KW 60HZ MTD PU617/M	MIL STD 4A032-1,2
6115007386336	GEN ST 10KW 60HZ MTD PU332A/G	MIL STD 4A084-2,3
6115007386337	GEN ST 5KW 60HZ MTD PU618/M	MIL STD 2A042 2,3
6115007386338	GEN ST 5KW 60HZ MTD PU409A/M	MIL STD 2A042 2,3
6115007386339	GEN ST 10KW 60HZ TM PU619/M	MIL STD 4A084-2,3
6115007386340	GEN ST 5KW 60HZ MTD PU 620/M	MIL STD 2A042-2,3
6115007386341	GEN ST 10KW 60HZ MTD PU564A/G	MIL STD 4A084-2,3
6115007532231	GEN ST 10KW 400HZ MTD PU 375A/G	CONT MTRS FS162
6115007592768	GEN ST 2KW 12V HLSWTH JHGV2C	CLINTON 416-1300
6115007718107	GEN ST 0.5KW 60HZ G0536AS1A08-2	MIL STD 1A08-1,2,3
6115007749342	GEN ST 1.5KW 60HZ W1PM1536S2A016	MIL STD 2A016-1,2,3
6115007786004	GEN ST 3KW 60HZ HLSWTH JHGW3B	WISCONSIN MOTOR MAENLD
6115007786005	GEN ST 10KW 60HZ HOLGAR CE106ACWK9	CONTINENTAL MTRS FS162
6115007893655	GEN ST 10KW 400HZ MTD PU684/GLQ-3	MIL STD 48084-3
6115007893656	GEN ST 10KW 400HZ MTD PU681/TLQ-15	MIL STD 4A084-3
6115007990667	GEN ST 3KW 28V MTD GAMA-1	WISCONSIN MOTOR MAENLD
6115008165929	GEN ST 2KW 12V US MOT2US18086	WISCONSIN MOTOR MBKND
6115008331498	GEN ST 10KW 60HZ K AND R FERO-1	HERCULES ENG 1XB-3ER

6115008492323	GEN ST 1.5KW 28V WIPG1528T2A016	MIL STD 2A016-1,2,3
6115008559572	GEN ST 10KW 400HZ BOGUE 5380	WISCONSIN MOTOR MVH4D
6115008571397	GEN ST GAS ENG 4.2KW 28V	MIL STD 4A032-1,2
6115008602251	GEN ST 2KW 12V KECO EG-2	CLINTON 416-1300
6115008733915	GEN ST 3KW 60HZ MTD PU625/G	MIL STD 4A032-1,2
6115008878644	GEN ST 1.5KW 60HZ HOLGAR CE9115AC	MIL STD 2A016-1,2,3
6115008891212	GEN ST 0.3KW 400HZ PU 5321PPS4	BRIGGS & STRATTON 60432
6115008891446	GEN ST 1.5KW 60HZ MEP015A	MIL STD 2A016-1,2,3
6115008891447	GEN ST 10KW 40HZ MEP 018A	MIL STD 4A084-2,3
6115008961981	GEN ST 3KW 28V MTD HLSWTH JHGV3A	WISCONSIN MOTOR MAENLD
6115009031208	GEN ST 5KW 400HZ JETA MG5400	WISCONSIN MOTOR MTHDE
6115009034948	GEN ST 7.5KW 28V MTD BENDIX59B2-1A	WISCONSIN MOTOR MVH4D
6115009234469	GEN ST 0.5KW 60HZ MEP014A	MIL STD 1A08-1,2,3
6115009260843	GEN ST 10KW 400HZ MEP023A	MIL STD 4A084-2,3
6115009268335	GEN ST 7.5KW 28V MTD BENDIX59B2-1B	WISCONSIN MOTOR MVH4D
6115009309498	GEN ST 0.125KW 400HZ BM HMLTEXLA	HOMELITE A54770
6115009316789	GEN ST 10KW 400HZ MTD PU375B/G	MIL STD 4A084-111
6115009339983	GEN ST 0.15KW 60HZ SM BOGUE ELEC6150	HOMELITE XL-12
6115009375555	GEN ST 5KW 60HZ MTD PU629/G	MIL STD 2A042-2,3
6115009378468	GEN ST 10KW 400HZ MTD PU678/M	MIL STD 4A084-3
6115009407862	GEN ST 0.5KW 400HZ MEP019A	MIL STD 1A08-1,2,3
6115009407867	GEN ST 0.5KW 28V MEP024A	MIL STD 1A08-1,2,3
6115009722326	GEN ST 10KW 400HZ BOGUE 5380A	WISCONSIN MOTOR MVH4D
6115009758381	GEN ST 3KW 60HZ HLSWTH JHGW3C	WISCONSIN MOTOR MAENLD
6115009758382	GEN ST 3KW 28V MTD HLSWTH JHGV3B	WISCONSIN MOTOR MAENLD
6115009893296	GEN ST 10KW 400HZ MTD PU656/G	MIL STD 4A084-2,3
6115009995935	GEN ST 7.5KW 28V MTD ATLAS POLMC111	WISCONSIN MOTOR MVH4D

GAS TURBINE GENERATOR SETS, POWER PLANTS AND POWER UNITS BY NSN

NSN	DESCRIPTION	ENGINE
6115000746442	GEN ST GT 750KW 60HZ GTE PU697/M	SOLAR T-1020 S-39
6115000751639	GEN ST GT 30KW 400HZ GTGE 70-6-1	AIRESEARCH GTP70-50
6115001263024	GEN ST GT 60KW 400HZ MEP404A	SOLAR TITAN
6115001340825	POWER UNIT GT UTIL (MUST) PPU85-4	AIRESEARCH GTC85-127
6115001653842	PWR PL UTIL PU-71	AIRESEARCH GTC85-127
6115007585492	GEN ST GT 50KW 400HZ GTGE 70-9-2	AIRESEARCH GTP70-50
6115007788788	GEN ST GT 30KW 400HZ GTGE70-1	AIRESEARCH GTP70-18-1
6115008496030	GEN ST GT 30KW 400HZ GTGE70-2W	AIRESEARCH GTP70-18-1
6115009370929	POWER UNIT GT UTIL (MUST) PPU85-5	AIRESEARCH GTC85-127
6115009677005	GEN ST GT 30KW 400HZ MTD	AIRESEARCH GTP-70-18-1
6115009991899	GEN ST GT GE30-23	AIRESEARCH GTP30-40
6115010272342	GEN ST GT 10KW 400HZ D423A	SOLAR GENINI

DIESEL POWERED GENERATOR SETS, POWER PLANTS AND POWER UNITS BY NSN

NSN	DESCRIPTION	ENGINE
6115000162356	GEN ST DED 45KW 400HZ MTD PU614/M	CUMMINS JS-G/S/S52300
6115000229656	GEN ST DED 150KW 60HZ LAT D353PR PWR	CATERPILLAR TRAC D333
6115000331373	GEN ST DED 5KW 60HZ PU751/M	ONAN DIV DJE-99/9485
6115000331389	GEN ST DED 10KW 60HZ PU753/M	ONAN DIV DJF-99/9487
6115000331395	PWR PLT DED 5KW 60HZ AN/MJQ-16	ONAN DIV DJE-99/9485
6115000331398	PWR PLT DED 10KW 60HZ AN/MJQ-18	ONAN DIV DJF-99E/9487
6115000567906	PWR PLT 30KW 60HZ AN/MJQ-10	DETROIT DIESEL 5033-7101
6115000759122	GEN ST DED 45KW 60HZ HLSWTHDW45A	CONTINENTAL MTRS TD427
6115000778600	GEN ST DED 30KW 60HZ HOLG CE301ACWK1	DETROIT DIESEL 5033-7101
6115000812030	GEN ST DED 100KW 60HZ MIL26727	CUMMINS ENGINE NH-220-B1
6115000895099	GEN ST DED 15KW 400HZ HOLGAR SPHF-15	HERCULES ENGINE D198ER
6115001181240	GEN ST DED 30KW 60HZ MEP 005A	HERCULES ENG D298-ERX37
6115001181241	GEN ST DED 15KW 60HZ MEP004A	HERCULES ENG D198-ERX51
6115001181243	GEN ST DED 60KW 60HZ MEP006A	ALLISCHALMERS 3500
6115001181244	GEN ST DED 15KW 400HZ MEP113A	HERCULES ENG D198-ERX51
6115001181245	GEN ST DED 15KW 60HZ MEP 103A	HERCULES ENG D198-ERX51
6115001181247	GEN ST DED 30KW 60HZ MEP104A	HERCULES ENG D298-ERX37
6115001181248	GEN ST DED 30KW 400HZ MEP114A	HERCULES ENG D298-ERX37
6115001181252	GEN ST DED 60KW 60HZ MEP105-A	ALLIS CHALMERS 3500
6115001181253	GEN ST DED 60KW 400HZ MEP115A	ALLIS CHALMERS 3500
6115001257876	GEN ST DED 60KW 60HZ PU700M	CUMMINS ENGINE C 180B1
6115001320488	GEN ST DED 60KW 60HZ PU699/M	CUMMINS ENGINE C 180B1
6115001339101	GEN ST DED 100KW 60HZ MEP 007A	CATERPILLAR TRAC D333C
6115001339102	GEN ST DED 100KW 60HZ MEP106A	CATERPILLAR TRAC D333C
6115001339103	GEN ST DED 100KW 60HZ MEP116A	CATERPILLAR TRAC D333C
6115001339104	GEN ST DED 200KW 60HZ MEP 009A	CATERPILLAR TRAC D334T
6115001348485	PWR PLT DED 200KW 60HZ MTD AN/MJQ-11	ALLIS CHALMERS 25000
6115001564342	GEN ST DED 100KW 60HZ JTA D8001M	ALLIS CHALMERS 11000
6115001677468	PWR PLT 60KW 60HZ AN/MJQ-14	ALLIS CHALMERS 3500
6115002203878	GEN ST DED 60KW 60HZ PU650A/G	CUMMINS ENGINE C 180B1
6115002504402	PWR PLT DED 4500KW 60HZ	GMC ENGINE 16576E-4
6115002504403	PWR PLT DED 4500KW 60HZ	GMC ENGINE 16576E-4
6115002504404	PWR PLT DED 1500KW 60HZ	CATERPILLAR TRAC D398
6115002504405	PWR PLT DED 2000KW 60HZ	CATERPILLAR TRAC D398
6115002571602	PWR PLT AN/MJQ-12A	CUMMINS C 180B1
6115002581622	GEN ST DED 60KW 60HZ PU650BG	HERCULES ENG D198ERX51
6115002603082	GEN ST DED 15KW 400HZ PU732/M	HERCULES ENG D198ERX51
6115003015761	GEN ST DED 100KW 60HZ CONSOL DSL 418	CONTINENTAL MTRS SD802
6115003949573	GEN ST DED 60KW 400HZ PU707A/M	CUMMINS C180B1
6115003949575	GEN ST DED 100KW 60HZ PU495A/G	CATERPILLAR TRAC D333C
6115003949576	GEN ST DED 30KW 60HZ PU406B/B	HERCULES ENG D298-ERX37
6115003949577	GEN ST DED 15KW 60HZ PU405A/M	HERCULES ENG D198-ERX51
6115003949581	GEN ST DSL 30KW 400HZ MTD PU760/M	HERCULES ENG D198ERX37
6115003949582	PWR PLT DED 30KW 60HZ AN/MIQ-10A	HERCULES ENG D198ERX37
6115003949583	PWR PLT DED 200KW 60HZ AN/MJQ-11A	CATERPILLAR TRAC D334T
6115004007591	PWR PLT ELEC AN/MJQ-15	HERCULES D198
6115004364228	GEN ST DED 200KW 60HZ WAUKESHA E812	WAUKESHA F1905 DSV-E812
6115004505881	GEN ST DED 750KW 60HZ MEP208A	CUMMINS KTA2300-G
6115004644194	PWR PLT 60KW 60HZ AN/MJQ-12	CUMMINS ENGINE C 180 B 1
6115004644195	GEN ST DED 60KW 400HZ PU 707/M	CUMMINS ENGINE C 18031
6115004651030	GEN ST DED 10KW 60HZ MEP003A	ONAN DIV DJF-99E/9487
6115004651044	GEN ST DED 5KW 60HZ MEP002A	ONAN DIV DJE-99E/9485
6115004756573	GEN ST DED 45KW 400HZ SSMDL 52300	STEW&STVS SERV 3045C
6115004765878	GEN ST DED 500KW 60HZ MEP011A	CUMMINS VTA-1710G

6115005426011	GEN ST DED 45KW 60HZ CUMJSGA601-45A	CUMMINS ENGINE JIS 600
6115005426012	GEN ST DED 45KW 400HZ CUMJSGA601-45	CUMMINS ENGINE JIS 600
6115005578744	GEN ST DED 45KW 400HZ S AND S 26200	STEW&STVS SERV 4045C
6115005916866	GEN ST DED 15KW 60HZ WINPWR D15H18Z	HERCULES ENG DD-198
6115006003404	GEN ST DED 150KW 60HZ WA6NKDBS EU1PR	WAUKESHA MOTOR 6NKDBS4N
6115006069693	GEN ST DED 15KW 60HZ US10327BA	US MOTORS HD260
6115006069985	GEN ST DED 60KW 60HZ SZDLYENG-501	CONTINENTAL MTRS RD572
6115006081614	GEN ST DED 60KW 60HZ CUM JS6G60KW-A	CUMMINS ENGINE JIS600
6115006200616	GEN ST DED 60KW 60HZ HOLG CE600ACEG	CONTINENTAL MTRS SD802
6115006204075	GEN ST DED 45KW 400HZ S AND S 28100	STEW&STVS SERV 3045C
6115006240385	GEN ST DED 45KW 400HZ CONSOL DSL 406	CONTINENTAL MTRS TD427
6115006242767	GEN ST DED 100KW 60HZ JTAMD1001815WW	ALLIS CHALMERS 11000
6115006242768	GEN ST DED 60KW 60HZ JTA MD601815W	JETA METAL FABR D-516
6115006279031	GEN ST DED 15KW 60HZ WPRO-15H 18M	WINPOWER MFG DD198
6115006352529	GEN ST DED 150-165KW 60HZ NHRSGA601	CUMMINS ENGINE NHR-600
6115006535634	GEN ST DED 15KW 60HZ JTA151815WWINT	HERCULES ENGINE DD198
6115006787794	GEN ST DED 30KW 60HZ 30US16936WINT	CONTINENTAL MTRS JD403
6115006934850	PWR PLT DED 45KW 60HZ AN/MJQ-4	CONT MTRS TD427-2281
6115007023347	GEN ST DED 45KW 60HZ PU407/M	CONTINENTAL MTRS TD427
6115007080032	GEN ST DED 45KW 400HZ CUM JS-6-G	CUMMINS ENGINE JS-6-1G
6115007090469	GEN ST DED 45KW 60HZ PU408/M	CONTINENTAL MTRS TD427
6115007120422	GEN ST DED 30KW 60HZ JTA MD3018115WW	JETA METAL FABR DD298
6115007136647	GEN ST DED 150KW 60HZ CUM NVH12G1200	CUMMINS ENGINE NVH-12-G
6115007223760	GEN ST DED 15KW 60HZ PU402/M	DETROIT DIESEL 5033-7101
6115007386342	GEN ST DED 30KW 60HZ PU406/M	DETROIT DIESEL 5033-7101
6115007681780	GEN ST DED 30KW 60HZ CLEO 1 WINT	HERCULES ENG D198ER
6115007877110	GEN ST DED 60KW 60HZ CUM JS66PR PWR	CUMMINS ENGINE JS-6-1G
6115007922541	GEN ST DED 100KW 60HZ CONSOL DSL 411	CONTINENTAL MTRS SD802
6115007983444	GEN ST DED 100KW 60HZ GMC 6910A	DETROIT DIESEL 6045C
6115008174919	GEN ST DED 15KW 60HZ J151815WA	HERCULES ENGINE DD198ER
6115008232213	GEN ST DED 45KW 400HZ PU401/M	CONTINENTAL MTRS SD802
6115008232217	GEN ST DED 45KW 400HZ PU410/M	CUMMINS ENG JIS-600
6115008232218	GEN ST DED 100KW 60HZ PU495/G	MEP106A/CATD333C/GMC6910
6115008303758	GEN ST DED 60KW 60HZ LUMEN207	CUMMINS ENGINE NH-220-G
6115008408258	GEN ST DED 45KW 60HZ CONSOL DSL 4150	CONSD DIESEL TD427
6115008460860	GEN ST DED 60KW 60HZ INTL MGODTTSH6	CONTINENTAL MTRS RD572
6115008891307	GEN ST DED 45KW 60HZ PU551/M	CONTINENTAL MTRS TD427
6115009228690	GEN ST DED 15KW 60HZ BOGUE MDL 6113	HERCULES ENGINE D198ER
6115009304240	GEN ST DED 60KW 60HZ AC3500-4472371	ALLIS-CHALMERS 3500
6115009333498	GEN ST DED 100KW 60HZ HOLT BROSHB333	CATERPILLAR TRAC D333
6115009355111	GEN ST DED 30KW 60HZ WESTHSESF30CIED	HERCULES ENG D298-ER
6115009358729	GEN ST DED 200KW 60HZ MEP108A	CATERPILLAR TRAC D334T
6115009373523	GEN ST DED 10KW 60HZ LIBBY 148002-1	HERCULES ENGINE D198ER
6115009374388	GEN ST DED 60KW 60HZ 60DGFH22X6001A	CUMMINS ENGINE C180
6115009374389	GEN ST DED 60KW 400HZ 60DGFJ402X6002	CUMMINS ENGINE C180
6115009375046	PWR PLT 15KW 60HZ MTD AN/MJQ-9	HERCULES ENGINE D198
6115009498409	GEN ST DED 15KW 60HZ PU405/M	BOGUE 6113/HERCULES D198
6115009517442	PWR PLT 200KW 60HZ AN/MJQ-5	ALLIS CHALMERS 25000
6115009700006	GEN ST DED 45KW 60HZ S AND S 54400	STEW&STVS SERV 5043
6115009768982	GEN ST DED 30KW 60HZ JTA MD3018115WA	JETA METAL FABR DD298H
6115009909833	GEN ST DED 60KW 60HZ LUMEN2207PRLOP	CUMMINS ENGINE NH-220-G
6115009997901	GEN ST DED 200KW 60HZ ALLIS CH444465	ALLIS-CHALMERS 25000
6115010306085	GEN ST DED 500KW 60HZ MEP029A	CUMMINS VTA-1710G
6115010366374	GEN ST DED 100KW 60HZ MEP007B	CATERPILLAR TRAC 3306

APPENDIX C

GENERATOR SETS, POWER PLANTS, AND POWER UNITS
BY ENGINE DESIGNATION

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GENERATOR SETS, POWER PLANTS AND POWER UNITS BY ENGINE DESIGNATION

ENGINE	DESCRIPTION	NSN
AIRESEARCH GTCP85-127	POWER UNIT GT UTIL (MUST) PPU85-5	6115009370929
AIRESEARCH GTCP85-127	POWER UNIT GT UTIL (MUST) PPU85-4	6115001340825
AIRESEARCH GTCP85-127	PWR PL UTIL PU-71	6115001653842
AIRESEARCH GTP-70-18-1	GEN ST GT 30KW 400HZ MTD	6115009677005
AIRESEARCH GTP30-40	GEN ST GT GE30-23	6115009991899
AIRESEARCH GTP70-18-1	GEN ST GT 30KW 400HZ GTGE70-2W	6115008496030
AIRESEARCH GTP70-18-1	GEN ST GT 30KW 400HZ GTGE70-1	6115007788788
AIRESEARCH GTP70-50	GEN ST GT 30KW 400HZ GTGE 70-6-1	6115000751639
AIRESEARCH GTP70-50	GEN ST GT 50KW 400HZ GTGE 70-9-2	6115007585492
ALLIS CHALMERS 11000	GEN ST DED 100KW 60HZ JTAMD1001815WW	6115006242767
ALLIS CHALMERS 11000	GEN ST DED 100KW 60HZ JTA D8001M	6115001564342
ALLIS CHALMERS 25000	PWR PLT 200KW 60HZ AN/MJQ-5	6115009517442
ALLIS CHALMERS 25000	PWR PLT DED 200KW 60HZ MTD AN/MJQ-11	6115001348485
ALLIS CHALMERS 25000	GEN ST DED 200KW 60HZ ALLIS CH444465	6115009997901
ALLIS CHALMERS 3500	GEN ST DED 60KW 60HZ MEP105-A	6115001181252
ALLIS CHALMERS 3500	GEN ST DED 60KW 400HZ MEP115A	6115001181253
ALLIS CHALMERS 3500	PWR PLT 60KW 60HZ AN/MJQ-14	6115001677468
ALLIS-CHALMERS 3500	GEN ST DED 60KW 60HZ AC3500-4472371	6115009304240
ALLIS-CHALMERS 3500	GEN ST DED 60KW 60HZ MEP006A	6115001181243
BRIGGS & STRATTON 60432	GEN ST 0.3KW 400HZ PU 532PPS4	6115004364230
BRIGGS & STRATTON 60432	GEN ST 0.4KW 400HZ ADMIRAL PU422	6115002250142
BRIGGS & STRATTON 60432	GEN ST 0.3KW 400HZ PU 5321PPS4	6115008891212
BRIGGS & STRATTON 60432	GEN ST 0.4KW 400HZ 909238-1A	6115002408729
CATERPILLAR TRAC D3306	GEN ST DED 100KW 60 HZ MEP007B	6115010366374
CATERPILLAR TRAC D333	GEN ST DED 100KW 60HZ HOLT BROSHB333	6115009333498
CATERPILLAR TRAC D333	GEN ST DED 150KW 60HZ LAT D353PR PWR	6115000229656
CATERPILLAR TRAC D333C	GEN ST DED 100KW 60HZ MEP116A	6115001339103
CATERPILLAR TRAC D333C	GEN ST DED 100KW 60HZ MEP 007A	6115001339101
CATERPILLAR TRAC D333C	GEN ST DED 100KW 60HZ MEP106A	6115001339102
CATERPILLAR TRAC D333C	GEN ST DED 100KW 60HZ PU495A/G	6115003949575
CATERPILLAR TRAC D334T	GEN ST DED 200KW 60HZ MEP108A	6115009358729
CATERPILLAR TRAC D334T	PWR PLT DED 200KW 60HZ AN/MJQ-11A	6115003949583
CATERPILLAR TRAC D334T	GEN ST DED 200KW 60HZ MEP 009A	6115001339104
CATERPILLAR TRAC D398	PWR PLT DED 1500KW 60HZ	6115002504404
CATERPILLAR TRAC D398	PWR PLT DED 2000KW 60HZ	6115002504405
CLINTON 416-1300	GEN ST 2KW 12V EGLE CE228	6115000759123
CLINTON 416-1300	GEN ST 2KW 12V HLSWTH JHGV2C	6115007592768
CLINTON 416-1300	GEN ST 2KW 12V KECO EG-2	6115008602251
CONSD DIESEL TD427	GEN ST DED 45KW 60HZ CONSOL DSL 4150	6115008408258
CONTINENTAL MTRS FS162	GEN ST 10KW 400HZ MTD PU 375A/G	6115007532231
CONTINENTAL MTRS FS162	GEN ST GAS ENG TM PU253/U	6115006972402
CONTINENTAL MTRS FS162	GEN ST 10KW 60HZ HOLCAR CE106ACWK9	6115007786005
CONTINENTAL MTRS FS162	GEN ST 10KW 60HZ PAC MER PM5901	6115006908290
CONTINENTAL MTRS JD403	GEN ST DED 30KW 60HZ 30US16936WINT	6115006787794
CONTINENTAL MTRS RD572	GEN ST DED 60KW 60HZ INTL MGODTTSH6	6115008460860
CONTINENTAL MTRS RD572	GEN ST DED 60KW 60HZ SZDLYENG-501	6115006069985
CONTINENTAL MTRS SD802	GEN ST DED 100KW 60HZ CONSOL DSL 418	6115003015761
CONTINENTAL MTRS SD802	GEN ST DED 60KW 60HZ HOLG CE600ACEG	6115006200616
CONTINENTAL MTRS SD802	GEN ST DSL ENG 45KW 400HZ PU401/M	6115008232213
CONTINENTAL MTRS SD802	GEN ST DED 100KW 60HZ CONSOL DSL 411	6115007922541

CONTINENTAL MTRS TD427	GEN ST DED 45KW 60HZ PU408/M	6115007090469
CONTINENTAL MTRS TD427	GEN ST DED 45KW 60HZ PU551/M	6115008891307
CONTINENTAL MTRS TD427	GEN ST DED 45KW 400HZ CONSOL DSL 406	6115006240385
CONTINENTAL MTRS TD427	GEN ST DED 45KW 60HZ PU407/M	6115007023347
CONTINENTAL MTRS TD427	GEN ST DED 45KW 60HZ HLSWTHDW45A	6115000759122
CONTINENTAL MTRS YS69	GEN ST 5KW 60HZ HOLGAR CE55ACWK6	6115006281243
CONTINENTAL MTRS TD427	PWR PLT 45KW 60HZ AN/MJQ-4	6115006934850
CUMMINS ENGINE C 180B1	PWR PLT AN/MJQ-12A	6115002571602
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 400HZ PU707A/M	6115003949573
CUMMINS ENGINE JIS-600	GEN ST DED 45KW 400HZ PU410/M	6115008232217
CUMMINS ENGINE C 180B1	PWR PLT 60KW 60HZ AN/MJQ-12	6115004644194
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 400HZ PU 707/M	6115004644195
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 60HZ PU650A/G	6115002203878
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 60HZ PU700M	6115001257876
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 60HZ PU699/M	6115001320488
CUMMINS ENGINE C180	GEN ST DED 60KW 60HZ 60DGFH22X6001A	6115009374388
CUMMINS ENGINE C180	GEN ST DED 60KW 400HZ 60DGFJ402X6002	6115009374389
CUMMINS ENGINE JIS 600	GEN ST DED 45KW 400HZ CUMJSGA601-45	6115005426012
CUMMINS ENGINE JIS 600	GEN ST DED 45KW 60HZ CUMJSGA601-45A	6115005426011
CUMMINS ENGINE JIS600	GEN ST DED 60KW 60HZ CUM JS6G60KW-A	6115006081614
CUMMINS ENGINE JS-6-1G	GEN ST DED 45KW 400HZ CUM JS-6-G	6115007080032
CUMMINS ENGINE JS-6-1G	GEN ST DED 60KW 60HZ CUM JS66PR PWR	6115007877110
CUMMINS ENGINE NH-220-BI	GEN ST DED 100KW 60HZ MIL26727	6115000812030
CUMMINS ENGINE NH-220-G	GEN ST DED 60KW 60HZ LUMEN207	6115008303758
CUMMINS ENGINE NH-220-G	GEN ST DED 60KW 60HZ LUMEN2207PRLOP	6115009909833
CUMMINS ENGINE NHRS-600	GEN ST DED 150-165KW 60HZ NHRSGA601	6115006352529
CUMMINS ENGINE NVH-12-G	GEN ST DED 150KW 60HZ CUM NVH12G1200	6115007136647
CUMMINS JS-G/S/S52300	GEN ST DED 45KW 400HZ MTD PU614/M	6115000162356
CUMMINS KTA2300-G	GEN ST DED 750KW 60HZ MEP208A	6115004505881
CUMMINS VTA-1710G	GEN ST DED 500KW 60HZ MEP029A	6115010306085
CUMMINS VTA-1710G	GEN ST DED 500KW 60HZ MEP011A	6115004765878
DETROIT DIESEL 5033-7101	GEN ST DED 15KW 60HZ PU402/M	6115007223760
DETROIT DIESEL 5033-7101	PWR PLT 30KW 60HZ AN/MJQ-10	6115000567906
DETROIT DIESEL 5033-7101	GEN ST DED 30KW 60HZ PU406/M	6115007386342
DETROIT DIESEL 5033-7101	GEN ST DED 30KW 60HZ HOLG CE301ACWK1	6115000778600
DETROIT DIESEL 6045C	GEN ST DED 100KW 60HZ GMC 6910A	6115007983444
GMC ENGINE 16576E-4	PWR PLT ELEC DED 4500KW 60HZ	6115002504403
GMC ENGINE 16576E-4	PWR PLT DED 4500KW 60HZ	6115002504402
HERCULES ENG D198	GENST DED 15 KW 60HZ PU485/M	6115009498409
HERCULES ENG D198	PWR PLT ELEC AN/MJQ-15	6115004007591
HERCULES ENG 1XB-3ER	GEN ST 10KW 60HZ K AND R FERO-1	6115008331498
HERCULES ENG D198-ERX51	GEN ST DED 15KW 400HZ MEP113A	6115001181244
HERCULES ENG D198-ERX51	GEN ST DED 15KW 60HZ MEP004A	6115001181241
HERCULES ENG D198-ERX51	GEN ST DED 15KW 60HZ PU405A/M	6115003949577
HERCULES ENG D198-ERX51	GEN ST DED 15KW 60HZ MEP 103A	6115001181245
HERCULES ENG D198ER	GEN ST DED 30KW 60HZ CLEO 1 WINT	6115007681780
HERCULES ENG D198ERX37	GEN ST DSL 30KW 400HZ MTD PU760/M	6115003949581
HERCULES ENG D198ERX37	PWR PLT DED 30KW 60HZ AN/MIQ-10A	6115003949582
HERCULES ENG D198ERX51	GEN ST DED 15KW 400HZ PU732/M	6115002603082
HERCULES ENG D198ERX51	GEN ST DED 60KW 60HZ PU650BG	6115002581622
HERCULES ENG D298-ER	GEN ST DED 30KW 60HZ WESTHSESF30CIED	6115009355111
HERCULES ENG D298-ERX37	GEN ST DED 30KW 400HZ MEP114A	6115001181248
HERCULES ENG D298-ERX37	GEN ST DED 30KW 60HZ PU406B/B	6115003949576
HERCULES ENG D298-ERX37	GEN ST DED 30KW 60HZ MEP104A	6115001181247

HERCULES ENG D298-ERX37	GEN ST DED 30KW 60HZ MEP 005A	6115001181240
HERCULES ENG DD-198	GEN ST DED 15KW 60HZ WINPWR D15H18Z	6115005916866
HERCULES ENGINE D198	PWR PLT 15KW 60HZ MTD AN/MJQ-9	6115009375046
HERCULES ENGINE D198ER	GEN ST DED 15KW 400HZ HOLGAR SPHF-15	6115000895099
HERCULES ENGINE D198ER	GEN ST DED 10KW 60HZ LIBBY 148002-1	6115009373523
HERCULES ENGINE D198ER	GEN ST DED 15KW 60HZ BOGUE MDL 6113	6115009228690
HERCULES ENGINE DD198	GEN ST DED 15KW 60HZ JTA151815WWINT	6115006535634
HERCULES ENGINE DD198ER	GEN ST DED 15KW 60HZ J151815WA	6115008174919
HOMELITE A 54770	GEN ST 0.5KW 28V HMLTE 5D28-23A	6115006356636
HOMELITE A54770	GEN ST 0.125KW 400HZ BM HMLTEXLA	6115009309498
HOMELITE XL-12	GEN ST 0.15KW 60HZ SM BOGUE ELEC6150	6115009339983
JETA METAL FABR D-516	GEN ST DED 60KW 60HZ JTA MD601815W	6115006242768
JETA METAL FABR DD298	GEN ST DED 30KW 60HZ JTA MD3018115WW	6115007120422
JETA METAL FABR DD298H	GEN ST DED 30KW 60HZ JTA MD3018115WA	6115009768982
MEP106A/CATD333C/GMC6910	GEN ST DED 100KW 60HZ PU495/G	6115008232218
MIL STD 1A08-1,2,3	GEN ST 0.4KW 400HZ MIL-G-52373	6115007267933
MIL STD 1A08-1,2,3	GEN ST 0.5KW 28V MEP024A	6115009407867
MIL STD 1A08-1,2,3	GEN ST 0.5KW 60HZ AF50-1A08-2	6115007305911
MIL STD 1A08-1,2,3	GEN ST 0.5KW 60HZ MEP014A	6115009234469
MIL STD 1A08-1,2,3	GEN ST 0.5KW 60HZ G0536AS1A08-2	6115007718107
MIL STD 1A08-1,2,3	GEN ST 0.5KW 400HZ MEP019A	6115009407862
MIL STD 2A016-1,2,3	GEN ST 1.5KW 60HZ KHLR KK15M25	6115005916867
MIL STD 2A016-1,2,3	GEN ST 1.5KW 28V PNR GEMTRCE15L	6115006466122
MIL STD 2A016-1,2,3	GEN ST 1.5KW 28V WIPG1528T2A016	6115008492323
MIL STD 2A016-1,2,3	GEN ST 1.5KW 60HZ W1PM1536S2A016	6115007749342
MIL STD 2A016-1,2,3	GEN ST 1.5KW 60HZ HOLGAR CE9115AC	6115008878644
MIL STD 2A016-1,2,3	GEN ST 1.5KW 28V MEP025A	6115000178236
MIL STD 2A016-1,2,3	GEN ST 1.5KW 60HZ MEP015A	6115008891446
MIL STD 2A042 2,3	GEN ST 5KW 60HZ MEP 017A	6115000178240
MIL STD 2A042 2,3	GEN ST 5KW 60HZ MTD PU618/M	6115007386337
MIL STD 2A042 2,3	GEN ST 5KW 400HZ MEP022A	6115000178241
MIL STD 2A042 2,3	GEN ST 5KW 60HZ MTD PU409A/M	6115007386338
MIL STD 2A042-11	GEN ST 5KW 60HZ TM PU409M	6115007023348
MIL STD 2A042-2,3	GEN ST 5KW 60HZ MTD PU 620/M	6115007386340
MIL STD 2A042-2,3	GEN ST 5KW 60HZ MTD PU629/G	6115009375555
MIL STD 2A042-2,3	GEN ST 5KW 60HZ MTD PU631/G	6115000595172
MIL STD 48084-3	GEN ST 10KW 400HZ MTD PU684/GLQ-3	6115007893655
MIL STD 4A032-1,2	GEN ST GAS ENG 4.2KW 28V	6115008571397
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MTD PU628/G	6115000870873
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MTD PU626/G	6115000870972
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MTD PU625/G	6115008733915
MIL STD 4A032-1,2	GEN ST 3KW 400HZ MTD MEP021A	6115000178238
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MEP016A	6115000178237
MIL STD 4A032-1,2	GEN ST 3KW 28V MTD MEP026A	6115000178239
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MTD PU617/M	6115007386335
MIL STD 4A032-1,2	GEN ST 3KW 28V MTD PU666/G	6115004859207
MIL STD 4A032-1,2	GEN ST 3KW 400HZ CON HF-30-MD	6115000751638
MIL STD 4A084-11	GEN ST 10KW 400HZ MTD PU304	6115006434674
MIL STD 4A084-11	GEN ST GAS ENG TM PU332/U	6115005778471
MIL STD 4A084-11	GEN ST 10KW 400HZ MTD PU304C/MPQ-4A	6115000568421
MIL STD 4A084-111	GEN ST 10KW 400HZ MTD PU375B/G	6115009316789
MIL STD 4A084-2,3	GEN ST 10KW 60HZ TM PU619/M	6115007386339
MIL STD 4A084-2,3	GEN ST 10KW 400HZ MTD PU656/G	6115009893296
MIL STD 4A084-2,3	GEN ST 10KW 400HZ MEP023A	6115009260843

MIL STD 4A084-2,3	GEN ST 10KW 40HZ MEP 018A	6115008891447
MIL STD 4A084-2,	GEN ST 10KW 60HZ MTD PU564A/G	6115007386341
MIL STD 4A084-3	GEN ST 10KW 400HZ MTD PU678/M	6115009378468
MIL STD 4A084-3	GEN ST 10KW 400HZ MTD PU681/TLQ-15	6115007893656
ONAN DIV DJE-99E/9485	GEN ST DED 5KW 60HZ MEP002A	6115004651044
ONAN DIV DJE-99/9485	PWR PLT DED 5KW 60HZ AN/MJQ-16	6115000331395
ONAN DIV DJF-99/9487	GEN ST DED 10KW 60HZ PU753/M	6115000331389
ONAN DIV DJF-99E/9487	GEN ST DED 10KW 60HZ MEP003A	6115004651030
ONAN DIV DJF-99E/9487	PWR PLT DED 10KW 60HZ AN/MJQ-18	6115000331398
ONAN DIV DJE-99/9485	GEN ST DED 5KW 60HZ PU751/M	6115000331373
SOLAR T-1020 S-39	GEN ST GT 750KW 60HZ GTE PU697/M	6115000746442
SOLAR TITAN	GEN ST GT 60KW 400HZ MEP404A	6115001263024
SOLAR GEMINI	GEN ST GT 10KW 400HZ D423A	6115010272342
STEW&STVS SERV 3045C	GEN ST DED 45KW 400HZ S AND S 28100	6115006204075
STEW&STVS SERV 3045C	GEN ST DED 45KW 400HZ SSMDL 52300	6115004756573
STEW&STVS SERV 4045C	GEN ST DED 45KW 400HZ S AND S 26200	6115005578744
STEW&STVS SERV 5043	GEN ST DED 45KW 60HZ S AND S 54400	6115009700006
US MOTORS HD260	GEN ST DED 15KW 60HZ US10327BA	6115006069693
WAUKESHA F1905 DSV-E812	GEN ST DED 200KW 60HZ WAUKESHA E812	6115004364228
WAUKESHA MOTOR 6NKDBS4N	GEN ST DED 150KW 60HZ WA6NKDBS EULPR	6115006003404
WINPOWER MFG DD198	GEN ST DED 15KW 60HZ WPWR0-15H 18M	6115006279031
WISCONSIN MOTOR MAENLD	GEN ST 3KW 60HZ SZEMCO 1021WIN	6115007318191
WISCONSIN MOTOR MAENLD	GEN ST 3KW 28V MTD HLSWTH JHGV3B	6115009758382
WISCONSIN MOTOR MAENLD	GEN ST 3KW 28V MTD HLSWTH JHGV3A	6115008961981
WISCONSIN MOTOR MAENLD	GEN ST 3KW 28V MTD GAMA-1	6115007990567
WISCONSIN MOTOR MAENLD	GEN ST 3KW 60HZ HLSWTH JHGW3C	6115009758791
WISCONSIN MOTOR MAENLD	GEN ST 3KW 60HZ HLSWTH JHGW3B	6115007786004
WISCONSIN MOTOR MBKND	GEN ST 2KW 12V US MOT2US18086	6115008165929
WISCONSIN MOTOR MTHDE	GEN ST 5KW 60HZ HOLGAR CE56AC	6115005605290
WISCONSIN MOTOR MTHDE	GEN ST 5KW 400HZ JETA MG5400	6115009031208
WISCONSIN MOTOR MTHDE	GEN ST 5KW 400HZ HOLGAR CE57400C	6115000778598
WISCONSIN MOTOR MVH4D	GEN ST 7.5KW 28V MTD BENDIX59B2-1B	6115009268335
WISCONSIN MOTOR MVH4D	GEN ST 7.5KW 28V MTD BENDIX59B2-1A	6115009034948
WISCONSIN MOTOR MVH4D	GEN ST 7.5KW 28V MTD HLSWTH JHGV7.5A	6115000746396
WISCONSIN MOTOR MVH4D	GEN ST 7.5KW 28V MTD ATLAS POLMC111	6115009995935
WISCONSIN MOTOR MVH4D	GEN ST 10KW 400HZ BOGUE 5380A	6115009722326
WISCONSIN MOTOR MVH4D	GEN ST 10KW 400HZ BOGUE 5380B	6115002261568
WISCONSIN MOTOR MVH4D	GEN ST 10KW 400HZ BOGUE 5380	6115008559572

APPENDIX D

GASOLINE-POWERED
GENERATOR SETS, POWER PLANTS, AND POWER UNITS
BY FUEL TYPE AND ENGINE DESIGNATION

DEPT. OF AGRICULTURE

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GASOLINE POWERED GENERATOR SETS, POWER PLANTS AND POWER UNITS BY ENGINE

ENGINE	DESCRIPTION	NSN
BRIGGS & STRATTON 60432	GEN ST 0.4KW 400HZ ADMIRAL PU422	6115002250142
BRIGGS & STRATTON 60432	GEN ST 0.3KW 400HZ PU 532PPS4	6115004364230
BRIGGS & STRATTON 60432	GEN ST 0.3KW 400HZ PU 5321PPS4	6115008891212
BRIGGS & STRATTON 60432	GEN ST 0.4KW 400HZ 909238-1A	6115002408729
CLINTON 416-1300	GEN ST 2KW 12V KECO EG-2	6115008602251
CLINTON 416-1300	GEN ST 2KW 12V EGLE CE228	6115000759123
CLINTON 416-1300	GEN ST 2KW 12V HLSWTH JHGV2C	6115007592768
CONTINENTAL MTRS FS162	GEN ST 10KW 400HZ MTD PU 375A/G	6115007532231
CONTINENTAL MTRS FS162	GEN ST 10KW 60HZ PAC MER PM5901	6115006908290
CONTINENTAL MTRS FS162	GEN ST 10KW 60HZ HOLGAR CE106ACWK9	6115007786005
CONTINENTAL MTRS FS162	GEN ST GAS ENG TM PU253/U	6115006972402
CONTINENTAL MTRS YS69	GEN ST 5KW 60HZ HOLGAR CE55ACWK6	6115006281243
HERCULES ENG 1XB-3ER	GEN ST 10KW 60HZ K AND R FERO-1	6115008331498
HOMELITE A 54770	GEN ST 0.5KW 28V HMLTE 5D28-23A	6115006356636
HOMELITE A54770	GEN ST 0.125KW 400HZ BM HMLTEXLA	6115009309498
HOMELITE XL-12	GEN ST 0.15KW 60HZ SM BOGUE ELEC6150	6115009339983
MIL STD 1A08-1,2,3	GEN ST 0.5KW 28V MEP024A	6115009407867
MIL STD 1A08-1,2,3	GEN ST 0.5KW 60HZ AF50-1A08-2	6115007305911
MIL STD 1A08-1,2,3	GEN ST 0.5KW 60HZ MEP014A	6115009234469
MIL STD 1A08-1,2,3	GEN ST 0.4KW 400HZ MIL-G-52373	6115007267933
MIL STD 1A08-1,2,3	GEN ST 0.5KW 60HZ G0536AS1A08-2	6115007718107
MIL STD 1A08-1,2,3	GEN ST 0.5KW 400HZ MEP019A	6115009407862
MIL STD 2A016-1,2,3	GEN ST 1.5KW 28V WIPG1528T2A016	6115008492323
MIL STD 2A016-1,2,3	GEN ST 1.5KW 60HZ KHLR KK15M25	6115005916867
MIL STD 2A016-1,2,3	GEN ST 1.5KW 28V MEP025A	6115000178236
MIL STD 2A016-1,2,3	GEN ST 1.5KW 60HZ W1PM1536S2A016	6115007749342
MIL STD 2A016-1,2,3	GEN ST 1.5KW 60HZ HOLGAR CE9115AC	6115008878644
MIL STD 2A016-1,2,3	GEN ST 1.5KW 28V PNR GEMTRCE15L	6115006466122
MIL STD 2A016-1,2,3	GEN ST 1.5KW 60HZ MEP015A	6115008891346
MIL STD 2A042 2,3	GEN ST 5KW 60HZ MEP 017A	6115000178240
MIL STD 2A042 2,3	GEN ST 5KW 400HZ MEP022A	6115000178241
MIL STD 2A042 2,3	GEN ST 5KW 60HZ MTD PU409A/M	6115007386338
MIL STD 2A042 2,3	GEN ST 5KW 60HZ MTD PU618/M	6115007386337
MIL STD 2A042-11	GEN ST 5KW 60HZ TM PU409M	6115007023348
MIL STD 2A042-2,3	GEN ST 5KW 60HZ MTD PU 620/M	6115007386340
MIL STD 2A042-2,3	GEN ST 5KW 60HZ MTD PU631/G	6115000595172
MIL STD 2A042-2,3	GEN ST 5KW 60HZ MTD PU629/G	6115009375555
MIL STD 48084-3	GEN ST 10KW 400HZ MTD PU684/GLQ-3	6115007893655
MIL STD 4A032-1,2	GEN ST GAS ENG 4.2KW 28V	6115008571397
MIL STD 4A032-1,2	GEN ST 3KW 28V MTD PU666/G	6115004859207
MIL STD 4A032-1,2	GEN ST 3KW 400HZ CON HF-30-MD	6115000751638
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MTD PU626/G	6115000870972
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MTD PU617/M	6115007386335
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MEP016A	6115000178237
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MTD PU625/G	6115008733915
MIL STD 4A032-1,2	GEN ST 3KW 28V MTD MEP026A	6115000178239
MIL STD 4A032-1,2	GEN ST 3KW 400HZ MTD MEP021A	6115000178238
MIL STD 4A032-1,2	GEN ST 3KW 60HZ MTD PU628/G	6115000870873
MIL STD 4A084-11	GEN ST 10KW 400HZ MTD PU304	6115006434674
MIL STD 4A084-11	GEN ST GAS ENG TM PU332/U	6115005778471

MIL STD 4A084-11	GEN ST 10KW 400HZ MTD PU304C/MPQ-4A	6115000568421
MIL STD 4A084-111	GEN ST 10KW 400HZ MTD PU375B/G	6115009316789
MIL STD 4A084-2,3	GEN ST 10KW 60HZ MTD PU564A/G	6115007386341
MIL STD 4A084-2,3	GEN ST 10KW 400HZ MEP023A	6115009260843
MIL STD 4A084-2,3	GEN ST 10KW 40HZ MEP 018A	6115008891447
MIL STD 4A084-2,3	GEN ST 10KW 400HZ MTD PU656/G	6115009893296
MIL STD 4A084-2,3	GEN ST 10KW 60HZ TM PU619/M	6115007386339
MIL STD 4A084-2,3	GEN ST 10KW 60HZ MTD PU332A/G	6115007386336
MIL STD 4A084-3	GEN ST 10KW 400HZ MTD PU681/TLQ-15	6115007893656
MIL STD 4A084-3	GEN ST 10KW 400HZ MTD PU678/M	6115009378468
WISCONSIN MOTOR MAENLD	GEN ST 3KW 28V MTD HLSWTH JHGV3B	6115009758382
WISCONSIN MOTOR MAENLD	GEN ST 3KW 60HZ HLSWTH JHGW3C	6115009758381
WISCONSIN MOTOR MAENLD	GEN ST 3KW 60HZ HLSWTH JHGW3B	6115007786004
WISCONSIN MOTOR MAENLD	GEN ST 3KW 60HZ SZEMCO 1021WIN	6115007318191
WISCONSIN MOTOR MAENLD	GEN ST 3KW 28V MTD GAMA-1	6115007990667
WISCONSIN MOTOR MAENLD	GEN ST 3KW 28V MTD HLSWTH JHGV3A	6115008961981
WISCONSIN MOTOR MBKND	GEN ST 2KW 12V US MOT2US18086	6115008165929
WISCONSIN MOTOR MTHDE	GEN ST 5KW 400HZ JETA MG5400	6115009031208
WISCONSIN MOTOR MTHDE	GEN ST 5KW 60HZ HOLGAR CE56AC	6115005605290
WISCONSIN MOTOR MTHDE	GEN ST 5KW 400HZ HOLGAR CE57400C	6115000778598
WISCONSIN MOTOR MVH4D	GEN ST 10KW 400HZ BOGUE 5380	6115008559572
WISCONSIN MOTOR MVH4D	GEN ST 10KW 400HZ BOGUE 5380B	6115002261568
WISCONSIN MOTOR MVH4D	GEN ST 7.5KW 28V MTD BENDIX59B2-1B	6115009268335
WISCONSIN MOTOR MVH4D	GEN ST 7.5KW 28V MTD BENDIX59B2-1A	6115009034948
WISCONSIN MOTOR MVH4D	GEN ST 7.5KW 28V MTD HLSWTH JHGV7.5A	6115000746396
WISCONSIN MOTOR MVH4D	GEN ST 10KW 400HZ BOGUE 5380A	6115009722326
WISCONSIN MOTOR MVH4D	GEN ST 7.5KW 28V MTD ATLAS POLMC111	6115009995935

GAS TURBINE GENERATOR SETS, POWER PLANTS AND POWER UNITS BY ENGINE

ENGINE	DESCRIPTION	NSN
AIRESEARCH GTCP85-127	PWR PL UTIL PU-71	6115001653842
AIRESEARCH GTCP85-127	POWER UNIT GT UTIL (MUST) PPU85-4	6115001340825
AIRESEARCH GTCP85-127	POWER UNIT GT UTIL (MUST) PPU85-5	6115009370929
AIRESEARCH GTP-70-18-1	GEN ST GT 30KW 400HZ MTD	6115009677005
AIRESEARCH GTP30-40	GEN ST GT GE30-23	6115009991899
AIRESEARCH GTP70-18-1	GEN ST GT 30KW 400HZ GTGE70-1	6115007788788
AIRESEARCH GTP70-18-1	GEN ST GT 30KW 400HZ GTGE70-2W	6115008496030
AIRESEARCH GTP70-50	GEN ST GT 50KW 400HZ GTGE 70-9-2	6115007585492
AIRESEARCH GTP70-50	GEN ST GT 30KW 400HZ GTGE 70-6-1	6115000751639
SOLAR T-1020 S-39	GEN ST GT 750KW 60HZ GTE PU697/M	6115000746442
SOLAR TITAN	GEN ST GT 60KW 400HZ MEP404A	6115001263024
SOLAR GEMINI	GEN ST GT 10KW 400HZ D423A	6115010272342

DIESEL POWERED GENERATOR SETS, POWER PLANTS AND POWER UNITS BY ENGINE

ENGINE	DESCRIPTION	NSN
ALLIS CHALMERS 11000	GEN ST DED 100KW 60HZ JTA D8001M	6115001564342
ALLIS CHALMERS 11000	GEN ST DED 100KW 60HZ JTAMD1001815WW	6115006242767
ALLIS CHALMERS 25000	PWR PLT 200KW 60HZ AN/MJQ-5	6115009517442
ALLIS CHALMERS 25000	PWR PLT DED 200KW 60HZ MTD AN/MJQ-11	6115001348485
ALLIS CHALMERS 3500	PWR PLT 60KW 60HZ AN/MJQ-14	6115001677468
ALLIS CHALMERS 3500	GEN ST DED 60KW 60HZ MEP105-A	6115001181252
ALLIS CHALMERS 3500	GEN ST DED 60KW 400HZ MEP115A	6115001181253
ALLIS-CHALMERS 25000	GEN ST DED 200KW 60HZ ALLIS CH444465	6115009997901
ALLIS-CHALMERS 3500	GEN ST DED 60KW 60HZ AC3500-4472371	6115009304240
ALLIS-CHALMERS 3500	GEN ST DED 60KW 60HZ MEP006A	6115001181243
CATERPILLAR TRAC D3306	GENST DED 100KW 60 HZ MEP 007B	6115010366374
CATERPILLAR TRAC D333	GEN ST DED 150KW 60HZ LAT D353PR PWR	6115000229656
CATERPILLAR TRAC D333	GEN ST DED 100KW 60HZ HOLT BROSHB333	6115009333498
CATERPILLAR TRAC D333C	GEN ST DED 100KW 60HZ MEP106A	6115001339102
CATERPILLAR TRAC D333C	GEN ST DED 100KW 60HZ MEP 007A	6115001339101
CATERPILLAR TRAC D333C	GEN ST DED 100KW 60HZ MEP116A	6115001339103
CATERPILLAR TRAC D333C	GEN ST DED 100KW 60HZ PU495A/G	6115003949575
CATERPILLAR TRAC D334T	GEN ST DED 200KW 60HZ MEP 009A	6115001339104
CATERPILLAR TRAC D334T	GEN ST DED 200KW 60HZ MEP108A	6115009358729
CATERPILLAR TRAC D334T	PWR PLT DED 200KW 60HZ AN/MJQ-11A	6115003949583
CATERPILLAR TRAC D398	PWR PLT DED 2000KW 60HZ	6115002504405
CATERPILLAR TRAC D398	PWR PLT DED 1500KW 60 HZ	6115002504404
CONSD DIESEL TD427	GEN ST DED 45KW 60HZ CONSOL DSL 4150	6115008408258
CONTINENTAL MTRS JD403	GEN ST DED 30KW 60HZ 30US16936WINT	6115006787794
CONTINENTAL MTRS RD572	GEN ST DED 60KW 60HZ INTL MGODTTS6	6115008460860
CONTINENTAL MTRS RD572	GEN ST DED 60KW 60HZ SZDLYENG-501	6115006069985
CONTINENTAL MTRS SD802	GEN ST DED 45KW 40 HZ PU401/M	6115008232213
CONTINENTAL MTRS SD802	GEN ST DED 60KW 60HZ HOLG CE600ACEG	6115006200616
CONTINENTAL MTRS SD802	GEN ST DED 100KW 60HZ CONSOL DSL 411	6115007922541
CONTINENTAL MTRS SD802	GEN ST DED 100KW 60HZ CONSOL DSL 418	6115003015761
CONTINENTAL MTRS TD427	PWR PLT DED DED 45KW 60 HZ AN/MJQ-4	6115006934850
CONTINENTAL MTRS TD427	GEN ST DED 45KW 60HZ PU407/M	6115007023347
CONTINENTAL MTRS TD427	GEN ST DED 45KW 60HZ HLSWTHDW45A	6115000759122
CONTINENTAL MTRS TD427	GEN ST DED 45KW 60HZ PU551/M	6115008891307
CONTINENTAL MTRS TD427	GEN ST DED 45KW 400HZ CONSOL DSL 406	6115006240385
CONTINENTAL MTRS TD427	GEN ST DED 45KW 60HZ PU408/M	6115007090469
CUMMINS ENGINE C 180B1	PWR PLT AN/MJQ-12A	6115002571602
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 400HZ PU707A/M	6115003949573
CUMMINS ENGINE JIS-600	GEN ST DED 45KW 400HZ PU410/M	6115008232217
CUMMINS ENGINE C 180B1	PWR PLT 60KW 60HZ AN/MJQ-12	6115004644194
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 400HZ PU 707/M	6115004644195
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 60HZ PU699/M	6115001320488
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 60HZ PU700M	6115001257876
CUMMINS ENGINE C 180B1	GEN ST DED 60KW 60HZ PU650A/G	6115002203878
CUMMINS ENGINE C180	GEN ST DED 60KW 60HZ 60DGFH22X6001A	6115009374388
CUMMINS ENGINE C180	GEN ST DED 60KW 400HZ 60DGFJ402X6002	6115009374389
CUMMINS ENGINE JIS 600	GEN ST DED 45KW 400HZ CUMJSGA601-45	6115005426012
CUMMINS ENGINE JIS 600	GEN ST DED 45KW 60HZ CUMJSGA601-45A	6115005426011
CUMMINS ENGINE JIS600	GEN ST DED 60KW 60HZ CUM JS6G60KW-A	6115006081614
CUMMINS ENGINE JS-6-1G	GEN ST DED 60KW 60HZ CUM JS66PR PWR	6115007877110

CUMMINS ENGINE JS-6-1G	GEN ST DED 45KW 400HZ CUM JS-6-G	6115007080032
CUMMINS ENGINE NH-220-BI	GEN ST DED 100KW 60HZ MIL26727	6115000812030
CUMMINS ENGINE NH-220-G	GEN ST DED 60KW 60HZ LUMEN2207PRLOP	6115009909833
CUMMINS ENGINE NH-220-G	GEN ST DED 60KW 60HZ LUMEN207	6115008303758
CUMMINS ENGINE NHRS-600	GEN ST DED 150-165KW 60HZ NHRSCA601	6115006352529
CUMMINS ENGINE NVH-12-G	GEN ST DED 150KW 60HZ CUM NVH12G1200	6115007136647
CUMMINS JS-G/S/S52300	GEN ST DED 45KW 400HZ MTD PU614/M	6115000162356
CUMMINS KTA2300-G	GEN ST DED 750KW 60HZ MEP208A	6115004505881
CUMMINS VTA-1710G	GEN ST DED 500KW 60HZ MEP011A	6115004765878
CUMMINS VTA-1710G	GEN ST DED 500KW 60HZ MEP029A	6115010306085
<u>DETROIT DIESEL 5033-7101</u>	<u>GEN ST DED 30KW 60HZ PU406/M</u>	<u>6115007386342</u>
DETROIT DIESEL 5033-7101	PWR PLT 30KW 60HZ AN/MJQ-10	6115000567906
DETROIT DIESEL 5033-7101	GEN ST DED 30KW 60HZ HOLG CE301ACWK1	6115000778600
DETROIT DIESEL 5033-7101	GEN ST DED 15KW 60HZ PU402/M	6115007223760
DETROIT DIESEL 6045C	GEN ST DED 100KW 60HZ GMC 6910A	6115007983444
GMC ENGINE 16576E-4	PWR PLT DED 4500KW 60HZ	6115002504403
GMC ENGINE 16576E-4	PWR PLT DED 4500KW 60HZ	6115002504402
HERCULES ENG D198	GEN ST DED 15KW 60HZ PU405/M	6115009498409
HERCULES ENG D198	PWR PLT ELEC AN/MJQ-15	6115004007591
HERCULES ENG D198-ERX51	GEN ST DED 15KW 60HZ MEP 103A	6115001181245
HERCULES ENG D198-ERX51	GEN ST DED 15KW 400HZ MEP113A	6115001181244
HERCULES ENG D198-ERX51	GEN ST DED 15KW 60HZ PU405A/M	6115003949577
<u>HERCULES ENG D198-ERX51</u>	<u>GEN ST DED 15KW 60HZ MEP004A</u>	<u>6115001181241</u>
HERCULES ENG D198ER	GEN ST DED 30KW 60HZ CLEO 1 WINT	6115007681780
HERCULES ENG D198ERX37	PWR PLT DED 30KW 60HZ AN/MIQ-10A	6115003949582
HERCULES ENG D198ERX37	GEN ST DSL 30KW 400HZ MTD PU760/M	6115003949581
HERCULES ENG D198ERX51	GEN ST DED 15KW 400HZ PU732/M	6115002603082
HERCULES ENG D198ERX51	GEN ST DED 60KW 60HZ PU650BG	6115002581622
HERCULES ENG D298-ER	GEN ST DED 30KW 60HZ WESTHSESF30CIED	6115009355111
HERCULES ENG D298-ERX37	GEN ST DED 30KW 60HZ MEP104A	6115001181247
HERCULES ENG D298-ERX37	GEN ST DED 30KW 60HZ MEP 005A	6115001181240
HERCULES ENG D298-ERX37	GEN ST DED 30KW 60HZ PU406B/B	6115003949576
HERCULES ENG D298-ERX37	GEN ST DED 30KW 400HZ MEP114A	6115001181248
HERCULES ENG DD-198	GEN ST DED 15KW 60HZ WINPWR D15H18Z	6115005916866
HERCULES ENGINE D198	PWR PLT 15KW 60HZ MTD AN/MJQ-9	6115009375046
HERCULES ENGINE D198ER	GEN ST DED 10KW 60HZ LIBBY 148002-1	6115009373523
HERCULES ENGINE D198ER	GEN ST DED 15KW 400HZ HOLGAR SPHF-15	6115000895099
HERCULES ENGINE D198ER	GEN ST DED 15KW 60HZ BOGUE MDL 6113	6115009228690
HERCULES ENGINE DD198	GEN ST DED 15KW 60HZ JTA151815WWINT	6115006535634
HERCULES ENGINE DD198ER	GEN ST DED 15KW 60HZ J151815WA	6115008174919
JETA METAL FABR D-516	GEN ST DED 60KW 60HZ JTA MD601815W	6115006242768
JETA METAL FABR DD298	GEN ST DED 30KW 60HZ JTA MD3018115WW	6115007120422
JETA METAL FABR DD298H	GEN ST DED 30KW 60HZ JTA MD3018115WA	6115009768982
MEP106A/CATD333C/GMC6910	GEN ST DED 100KW 60HZ PU495/G	6115008232218
ONAN DIV DJE-99E/9485	GEN ST DED 5KW 60HZ MEP002A	6115004651044
ONAN DIV DJE-99/9485	PWR PLT DED 5KW 60HZ AN/MJQ-16	6115000331395
ONAN DIV DJF-99/9487	GEN ST DED 10KW 60HZ PU753/M	6115000331389
ONAN DIV DJF-99E/9487	GEN ST DED 10KW 60HZ MEP003A	6115004651030
ONAN DIV DJF-99E/9487	PWR PLT DED 10KW 60HZ AN/MJQ-18	6115000331398
ONAN DIV DJE-99/9485	GEN ST DED 5KW 60HZ PU751/M	6115000331373
STEW&STVS SERV 3045C	GEN ST DED 45KW 400HZ SSMDL 52300	6115004756573
STEW&STVS SERV 3045C	GEN ST DED 45KW 400HZ S AND S 28100	6115006204075
STEW&STVS SERV 4045C	GEN ST DED 45KW 400HZ S AND S 26200	6115005578744
STEW&STVS SERV 5043	GEN ST DED 45KW 60HZ S AND S 54400	6115009700006
US MOTORS HD260	GEN ST DED 15KW 60HZ US10327BA	6115006069693
WAUKESHA F1905 DSV-E812	GEN ST DED 200KW 60HZ WAUKESHA E812	6115004364228
WAUKESHA MOTOR 6NKDBS4N	GEN ST DED 150KW 60HZ WA6NKDBS EULPR	6115006003404
WINPOWER MFG DD198	GEN ST DED 15KW 60HZ WPWRO-15H 18M	6115006279031

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DRCDE-DG (MR MCGOWAN)	1	US ARMY ABERDEEN PROVING GROUND	
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5001 EISENHOWER AVE		STEAP-MT-U (MR DEAVER)	1
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US ARMY TANK-AUTOMOTIVE CMD		US ARMY YUMA PROVING GROUND	
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DRSTA-NS (DR PETRICK)	1	YUMA AR 85364	
DRSTA-G	1	PROJ MGR, MOBILE ELECTRIC POWER	
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RSCH CTR
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NAVAL AIR STATION
PENSACOLA FL 32508

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LMM 1
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200 STOVWALL ST
ALEXANDRIA VA 22322

CDR
NAVY FACILITIES ENGRG CMD
CIVIL ENGR SUPPORT OFC
CODE 15312A (ATTN EOC COOK) 1
NAVAL CONSTRUCTION BATTALION CTR
PORT HUENEME CA 93043

CDR, NAVAL MATERIAL COMMAND
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CP6, RM 606
WASHINGTON DC 20360

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BASE ATLANTIC
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ALBANY GA 31704

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CTR
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KELLY AIR FORCE BASE, TX 78241

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CTR
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ROBINS AFB GA 31098

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20 MASSACHUSETTS AVENUE
WASHINGTON DC 20545

DIRECTOR
NATL MAINTENANCE TECH SUPPORT
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NORMAN OK 73069

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BARTLESVILLE ENERGY RSCH CTR
DIV OF UTILIZATION RES 1
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SCI & TECH INFO FACILITY
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